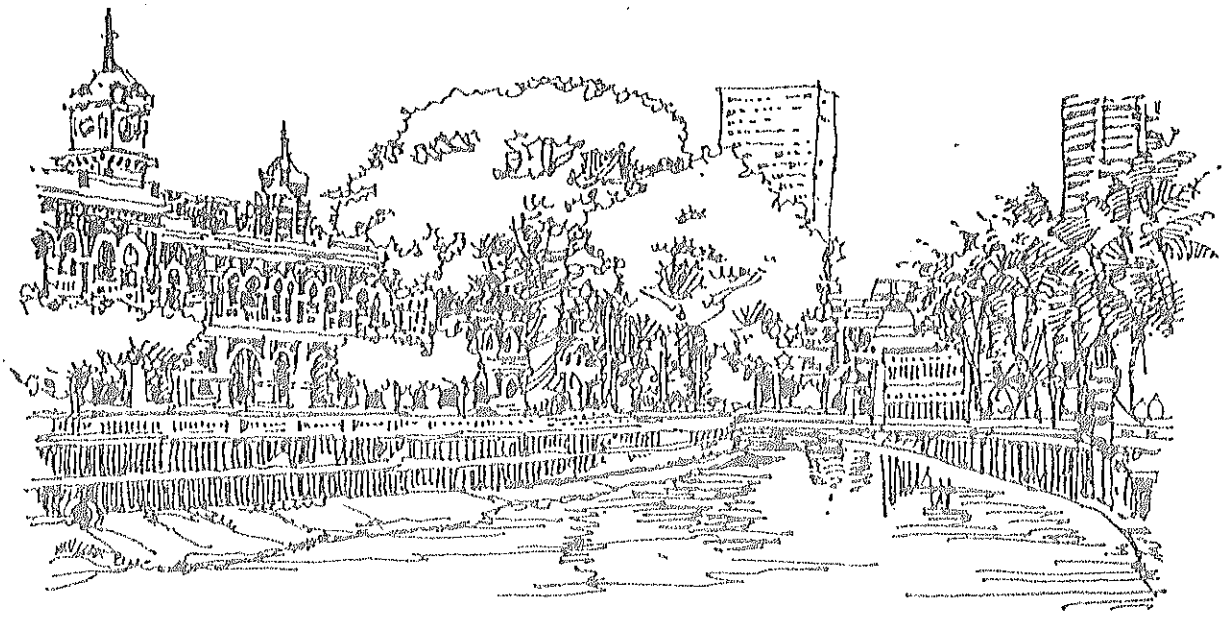
GOVERNMENT OF MALAYSIA

THE STUDY ON THE FLOOD MITIGATION OF THE KLANG RIVER BASIN

SUPPORTING REPORT
VOLUME I
(APPENDIX A～I)



JANUARY 1989

JAPAN INTERNATIONAL COOPERATION AGENCY

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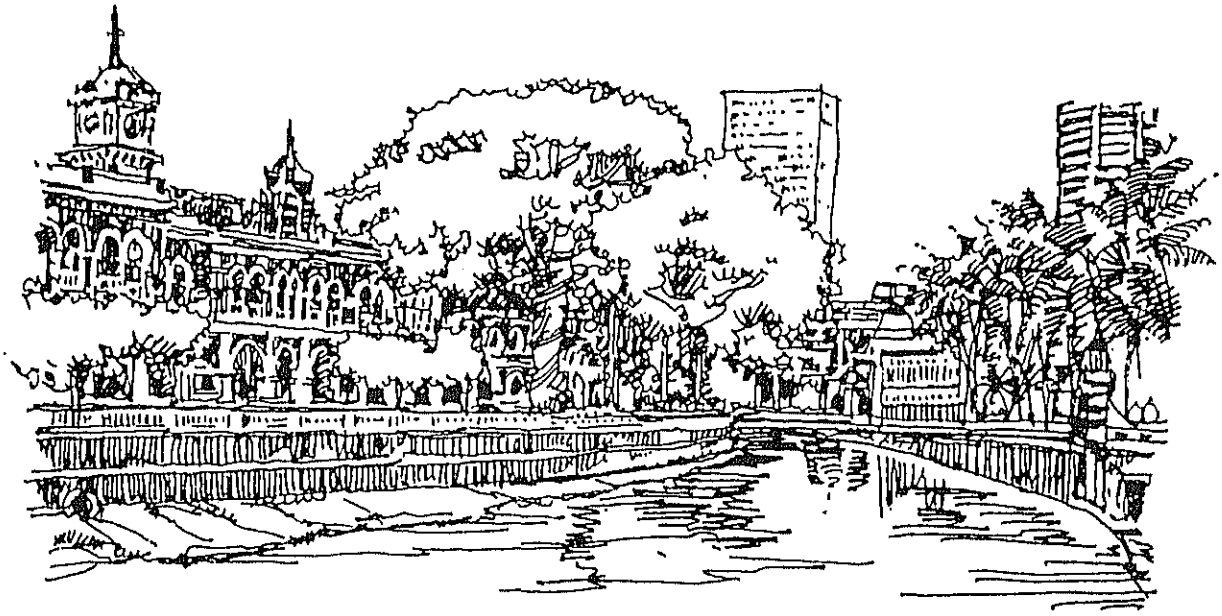

JANUARY 1989

JAPAN INTERNATIONAL COOPERATION AGENCY

SUPPORTING REPORT

VOLUME I
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APPENDIX A. TOPOGRAPHICAL SURVEY

1. INTRODUCTION

The topographical survey was conducted in order to obtain the necessary data to formulate a master plan for flood mitigation of the Klang River basin and a feasibility study for the selected projects.

The contents of the topographical survey to be covered include the following works:

- To collect the existing topographical data and recent aerial photographs,
- To update the existing topographical map in the flood prone areas in Kuala Lumpur,
- To execute a latest river survey along the Klang, Gombak and Batu River, which comprises both longitudinal and cross sectional surveys,
- To execute a topographical survey of the proposed Gombak and Batu Retention Pond areas and the Kampung Baru area, and
- To execute longitudinal and cross sectional survey for the proposed route of the Gombak Diversion Channel.

The existing topographical data was prepared by the Department of Survey and Mapping and by the Drainage and Irrigation Department (DID). All of survey works in this study were conducted by the study team during the study period in Malaysia.

2. EXISTING DATA COLLECTION

2.1 Topographical Maps

Table A-1 lists all the topographical maps made available for use in this study. These maps have been indexed in Figs. A-1 and A-2. These topographical maps are drawn on the Malayan Rectified Skew Orthomorphic Projection using Everest as a spheroid.

The origin of the Rectified Skew Orthomorphic grid is 4°N, 102° 15'E of Greenwich and the coordinates of the origin is 472,854 meters E, 442,420 meters N.

2.2 Aerial Photographs

The latest aerial photographs covering the Klang River basin (for downstream stretch covering only along the river) were taken in 1986 to a scale of 1:10,000. These were obtained from the Department of Survey and Mapping through DID.

The aerial photographs for the Federal Territory of Kuala Lumpur have already been compiled as photo mosaics and they correspond with the topographical maps with a scale of 1:10,000 in size and area, such as sheet numbers 6, 7, 8, 15, 16, 17, 24, 25 and 26 in the series No. L808 (see Table A-1).

For investigating the development changes in land use, similar photo mosaics with a scale of 1:10,000 taken in 1975 are also collected.

2.3 Data from Previous River Survey

The DID Project Office previously carried out river surveys for the implementation of the river improvement plan. The resulting data are shown in Table A-2.

The previous longitudinal profile survey of the Klang River was conducted in three stretches. These are from (1) Zoo Bridge to the Confluence of Klang and Gombak River along the Klang River, (2) Proposed Gombak Dam site to Pekeliling Bridge along the Gombak River and (3) Batu Dam site to Sentul Station along the Batu River.

For the reaches not included in the above stretches, longitudinal profiles were drawn by plotting levels extracted from existing cross sections along the Klang River, the Gombak River and the Batu River using Puchong Drop as the base point. Longitudinal profiles for the left bank, right bank and river bed were also derived in the same manner.

The cross sectional survey of the rivers was also carried out by DID at intervals of approximately 200 feet upstream of the Puchong Drop and approximately 500 feet downstream of the Puchong Drop along the Klang River over a period from 1973 to 1982. Along the Gombak River and the Batu River, the intervals of the cross sections are approximately 50 meters. These cross sections were taken over a period from 1974 to 1985.

2.4 Updating of Existing Topographical Maps

The updating of the existing topographical maps with a scale of 1:1,584 (1 inch:2 chain) in the flood prone areas in Kuala Lumpur was carried out by the Study Team using the most recent photo mosaics with a scale of 1:10,000 taken in 1986. There are, in total, sixty two sheets of maps.

3. RIVER SURVEY

3.1 General

The river survey carried out by this study consists of longitudinal and cross sectional surveys of the following stretches:

The Klang River	:	River Mouth to Klang Gates Dam
The Gombak River	:	Klang River Confluence to Proposed Gombak Dam Site
The Batu River	:	Gombak River Confluence to Batu Dam

The field survey was carried out during the period from October 9, 1987 to November 30, 1987.

The Land Survey Datum (LSD) is used as datum level. This LSD was determined at Port Swettenham (now called Port Klang) in 1912 by British Admiralty and relation between LSD and MSL (Mean Sea Level) at Port Klang is as follows:

$$LSD = MSL + 0.025 \text{ m}$$
$$MSL = DL + 2.272 \text{ m}$$

where, LSD means the Land Survey Datum

MSL means the Mean Sea Level at Port Klang derived from two years observation period

DL means the Datum Level of Chart
This is called Indian Low Water Springs and is an elevation depressed below MSL by an amount equal to the sum of the amplitude of the Harmonic Constituents M_2, S_2, K_1, O_1.

The origin of the coordinate is at Bukit Asa and its Longitude and Latitude are as follows;

Longitude : 101°30'29.68"E
Latitude : 3°40'49.24"N

3.2 Longitudinal Survey

The control points of the longitudinal survey are set up at intervals of about 200 m upstream of the Puchong Drop and at intervals of about 500 m downstream of the Puchong Drop. The coordinates of the control points are determined by traverse using the Selangor State Crossing Projection.

Total length of longitudinal survey: 118.3 km

i) Klang River : 90.1 km
   Downstream of Puchong Drop : 52.5 km
   Upstream of Puchong Drop : 37.6 km

ii) Gombak River : 13.3 km

iii) Batu River : 14.9 km

3.3 Cross Sectional Survey

The ground levels of all the cross sections are based on the heights of the control points.

The depth of the river is determined using an echo-sounder in the deeper water area and a graduated pole in the shallow water area.

At the bridge sites, the height of the bridge is measured as well as the cross section. The cross sections at the new water level stations are also surveyed.

Total Number of Cross Sections: 482 sections

i) Klang River : 295 sections
   Downstream of Puchong Drop : 106 sections
   (approx. 500 m interval)
   Upstream of Puchong Drop : 189 sections
   (approx. 200 m interval)

ii) Gombak River : 68 sections
   (approx. 200 m interval)

iii) Batu River : 75 sections
(approx. 200 m interval)

iv) Bridge Site : 51 sections

Klang River	:	25 sections
Gombak River	:	12 sections
Batu River	:	14 sections

v) Water Level Station Site: 2 sections

The Location of Cross Sectional Survey is shown in Fig. A-3.

3.4 Results of Survey

The results of the river survey works are shown in attached "Data Book". All the drawings are listed as follows;

1) Index Map (Scale 1:63,360)
2) Site of Temporary Bench Mark
3) Longitudinal Profiles
   - Klang River (60 sheets)
   - Gombak River (6 sheets)
   - Batu River (7 sheets)
4) Cross Section

4. TOPOGRAPHICAL SURVEY FOR THE URGENT PROJECTS

4.1 Contents of Works

The topographical survey was carried out to obtain the necessary data to formulate a feasibility study for the selected project sites. A location map of survey works is shown in Fig. A-4.

Topographical survey of proposed two retention pond areas of Gombak and Batu, and of Kampung Baru area were carried out, as well as longitudinal and cross sectional surveys of proposed route of Gombak Diversion Channel connecting the Gombak River and the Batu River.

4.2 Topographical Survey

Topographical Survey was carried out for three areas namely the Batu and Gombak Retention Pond areas and Kampung Baru area.

The Batu Retention Pond area surveyed covers about 50 ha of land, a major portion of which was once a mining pond. The topographical map of 1:5,000 scale were prepared with 1.0 m contour interval.

The Gombak Retention Pond area surveyed covers about 25 ha of land and is mainly Malay Reservation with scattered settlements. The topographical map of 1:5,000 scale were prepared with 1.0 m contour interval.

The Kampung Baru area surveyed covers about 15 ha of land and is mostly occupied by housing units. The topographical map of 1:2,000 scale were prepared with 0.5 m contour interval.

4.3 Longitudinal and Cross Sectional Survey

A Longitudinal and Cross Sectional Survey was carried out for the route area along the proposed diversion channel between the Gombak Retention Pond and the Batu Retention Pond. This stretches 3.2 km between the two pond areas.

The control points were set up at intervals of 150 m along the proposed diversion channel. Coordinates of the control points were determined by levelling and were tied to the existing Bench Marks or Temporary Bench Marks. The accuracy of the levelling work was 2 cm/S, where S is in kilometer. The Reduce Level is used as datum level.

The results of survey were presented with a horizontal (H) scale of 1:5,000 and a vertical (V) scale of 1:100 in the longitudinal survey, and with a horizontal (H) scale of 1:200 and vertical (V) scale of 1:100 in the cross sectional survey.

4.4 Bathymetric Survey

A bathymetric survey covering 30 ha was carried out over the existing pond in the proposed Batu Retention Pond area. The depth of the pond was established by using an echo-sounder in the deeper area. The sound velocity was corrected using the Bar-check method. In the shallower area of the pond, a graduated pole was used. The spacing survey lines were set at 25 m apart.

Daily reading of the pond water level was taken during the period of the bathymetric survey. The results of survey was used to produce a contour map of 1:5,000 scale with 2.5 m contour intervals together in the topographical map.

4.5 Results of Survey

The results of the topographical survey works are shown in attached "Data Book". All the drawings are listed as follows;

1) Location Map
2) Topographical Map
   - Gombak Retention Pond Area
   - Batu Retention Pond Area
   - Kampung Baru Area
3) Longitudinal Profile for Gombak Diversion Channel
4) Cross Section for Gombak Diversion Channel

Table A-1 COLLECTED TOPOGRAPHICAL MAPS (1/3)

Series No. (Scale)	Area/Sheet No. (Title)	Published in	(Air Survey Photography) Field Survey/Revision	Remarks
L 7010 (1/63,360)	86: Kuala Kubu Baharu	1974	1970	One Inch to a Mile. Heights in Feet above Mean Sea Level. Contour Interval; 50 Feet except 86, 100 Feet for 86.
	93: Pelabuhan Kelang & Kelang	1974	1970	
	94: Kuala Lumpur	1974	1970	
	101: Telok Datok	1974	1971	
	102: Sepang	1974	(1947 to 51), 1962	
L 8010 (1/25,000)	93.c: Kampung Merbau Sempak	1972	(1959 to 62) 1962 to 63, 1970	Height in Feet above Mean Sea Level. Contour Interval; 50 Feet.
	e: Kapar	1970	(1959 to 62) 1962 to 63,	
	f: Kelang	1966	(1959 to 62) 1963	
	h: Port Swettenham	1971	(1959 to 62) 1962 to 63, 1970	
	j: Selangor	1963	(1959 to 62) 1962 to 63,	
	94.a: Kepong	1975	(1947 to 62) 1961 to 62,	
	b: Sentul	1971	(1957 to 62) 1961 to 62, 1969	
	c: Pekan Batu Lapan Belas	1970	(1947 to 62) 1961 to 62, 1969	
	d: Batu Tiga	1970	(1947 to 62) 1961 to 62,	
	e: Sungai Besi	1976	(1961 to 62) 1931 to 32, 1966	
	f: Ulu Langat	1976	(1947 to 62) 1961 to 62, 1969	
	g: Puchong Batu Dua Belas	1972	(1957) 1962, 1969	
	h: Serdang Baharu	1970	(1947 to 62) 1961 to 62, 1969	
	j: Kajang	1970	(1947 to 62) 1961 to 62,	
	k: Kuala Lumpur	1976	(1947 to 62) 1961 to 62, 1966	
	101.b: Telok Datok	1976	(1951.57 & 60) 1961, 1971	

Table A-1 COLLECTED TOPOGRAPHICAL MAPS (2/3)

(CONT'D)

Series No. (Scale)	Area/Sheet No. (Title)	Published in	Field Survey /Revision	Remarks
L 808 (1/10,000)	5: Sungai Buluh	1984	1980	Heights in Feet above Mean Sea Level. Contour Interval; 25 Feet. Photogrammetric Plot from Aerial Photograph; 1969 except sheet 29 & 38, 1975 for sheet 29 & 38
	6: Jinjang	1986	1979	
	7: Gombak Setia	1984	1978	
	8: Kampung Kelang Gates Baharu	1983	-	
	9: Bukit Cenuang	1982	-	
	12: Meru	1983	-	
	13: Subang	1982	-	
	14: Bukit Lanjan	1977	-	
	15: Damansara	1985	1980	
	16: Kuala Lumpur	1973	-	
	17: Ampang	1985	1980	
	18: Pekan Batu Lapan Belas Hulu Langat	1981	-	
	20: Kampung Sementa	1984	1981	
	21: Kelang Utara	1984	1981	
	22: Shah Alam	1984	1981	
	23: Subang Jaya	1986	1980	
	24: Petaling Jaya	1978	-	
	25: Salak Selatan	1987	1975	
	26: Pekan Batu *Sembilan*	1984	1975	
	27: Hulu Langat	1982	-	
	28: Pelabuhan Klang Utara	1983	-	
	29: Pelabuhan Klang	1985	1981	
	30: Kelang Selatan	1986	1980	
	31: Kampung Bukit Kemuning	1984	1981	
	32: Kg. Batu Tiga Suku Puchong	1976	-	
	33: Petaling	1982	-	
	34: Seri Kembangan	1984	1972	
	35: Kajang	1985	1976	
	38: Kampung Telok Gedong	1985	1981	
	39: Teluk Panglima Garang	1983	-	
	40: Kampung Bukit Kemandul	1984	-	
	41: Kampung Tanah Liat	1985	1981	
	42: Kampung Pulau Meranti	1985	1981	
	43: Kg. Datok Abu Bakar Baginda	1983	-	
	44: Bandar Baharu Bangi	1984	1979	

Table A-1 COLLECTED TOPOGRAPHICAL MAPS (3/3)

(CONT'D)

Name (Scale)	Area/Sheet No.	Remarks
J.P.T Wilayah Persekutuan (1/1,584)	50/ 54. 55. 56. 57 .58 .59 .60 .61 .62 51/ 54. 55. 56 .57 .58 .59. 60. 61. 62 52/ 54. 55. 56. 57. 58 .59. 60. 61. 62 53/ 54. 55. 56. 57. 58. 59. 60. 61. 62 54/ 54. 55. 56. 57. 58. 59. 60. 61. 62 55/ 54. 55. 56. 57. 58. 59. 60. 61. 62 56/ 54. 55. 56. 57. 58. 59. 60. 61. 62 57/ 55. 56. 57. 58. 59. 60. 61. 62 58/ 55. 56. 57. 58. 59. 60. 61 59/ 55. 56. 57. 58. 59. 60. 61 60/ 55. 56. 57. 58. 59. 60. 61 61/ 56. 57. 58 62/ 55. 56. 57. 58 63/ 55. 56. 57 64/ 55. 56 65/ 54. 55. 56 66/ 54. 55. 56 67/ 54. 55. 56 68/ 53. 54. 55. 56 69/ 53. 54. 55 70/ 53. 54	One Inch to Two Chains. Contour Interval; 10 Feet. Aerial Photograph 1974.

Table A-2 DATA FROM PREVIOUS RIVER SURVEYS

Name of River	River Stretch	Surveyed in	Remarks
Klang Rilver	Zoo Bridge to 3rd Mile Railway Bridge (Off Jln, Klang)	Dec. 1973 to Oct. 1974	Portion A-B, B-C, C-D. Cross Section Interval; approx. 200 Feet.
	3rd Mile Railway Bridge to 5th Mile Jln, Klang Bridge	Apr. 1982	Portion D-H. Cross Section Interval; approx. 200 Feet.
	5th Mile Jln, Klang Bridge to Puchong Drop	Oct. 1974	Portion H-I. Cross Section Interval; approx. 200 Feet.
	Puchong Drop to Kuala (Port Klang)	Oct. 1975 to Feb. 1976	Portion I-J. Cross Section Interval; approx. 500 Feet.
Gombak River	Proposed Gombak Dam Site to Sg. Gombak/Belongkong Confluence	Oct. to Nov. 1985	Portion K-L. Cross Section Interval; 50 Meters.
	Sg. Gombak/Belongkong Confluence to Sg. Gombak/ Klang Confluence	Jul. 1974	Portion L-M. Cross Section Interval; approx. 200 Feet.
Batu River	10th Mile Railway Bridge to 6.1/2 Mile Railway Bridge	Oct. 1983	Portion N-P (Upstream). Cross Section Interval; 50 Meters.
	6.1/2 Mile Railway Bridge to 4.1/2 Mile Jln. Ipoh Bridge	Nov. 1983	Portion N-P (Downstream). Cross Section Interval; 50 Meters.
	4.1/2 Mile Jln. Ipoh Bridge to Sg. Batu/Gombak Confluence	Aug. to Sep. 1974	Portion P-Q. Cross Section Interval; approx. 200 Feet.

[Note] Locations of the river stretch are shown in Appendix E

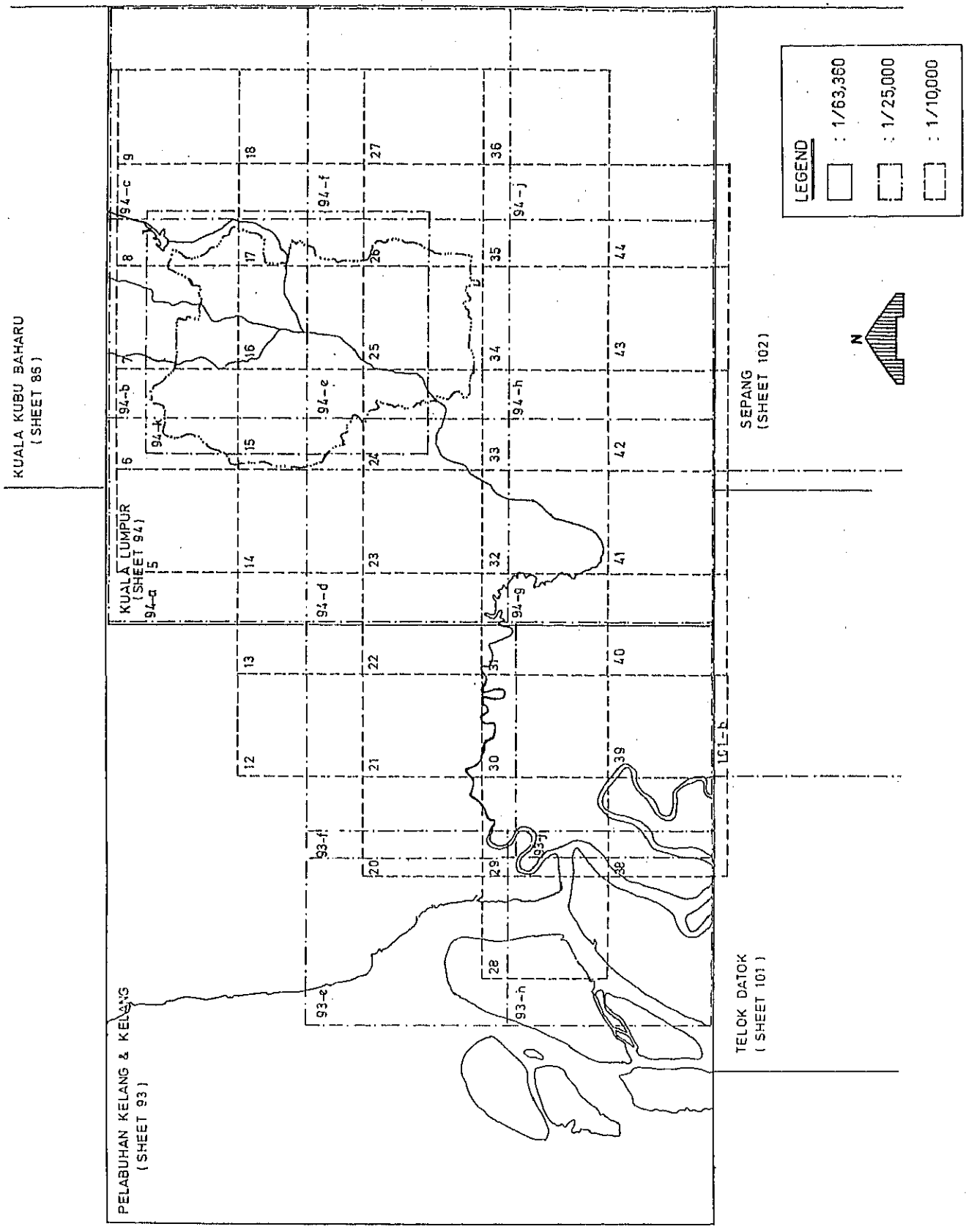

FIG. **A-1** **INDEX MAP OF TOPOGRAPHICAL MAPS**

THE STUDY ON THE FLOOD MITIGATION OF THE KLANG RIVER BASIN

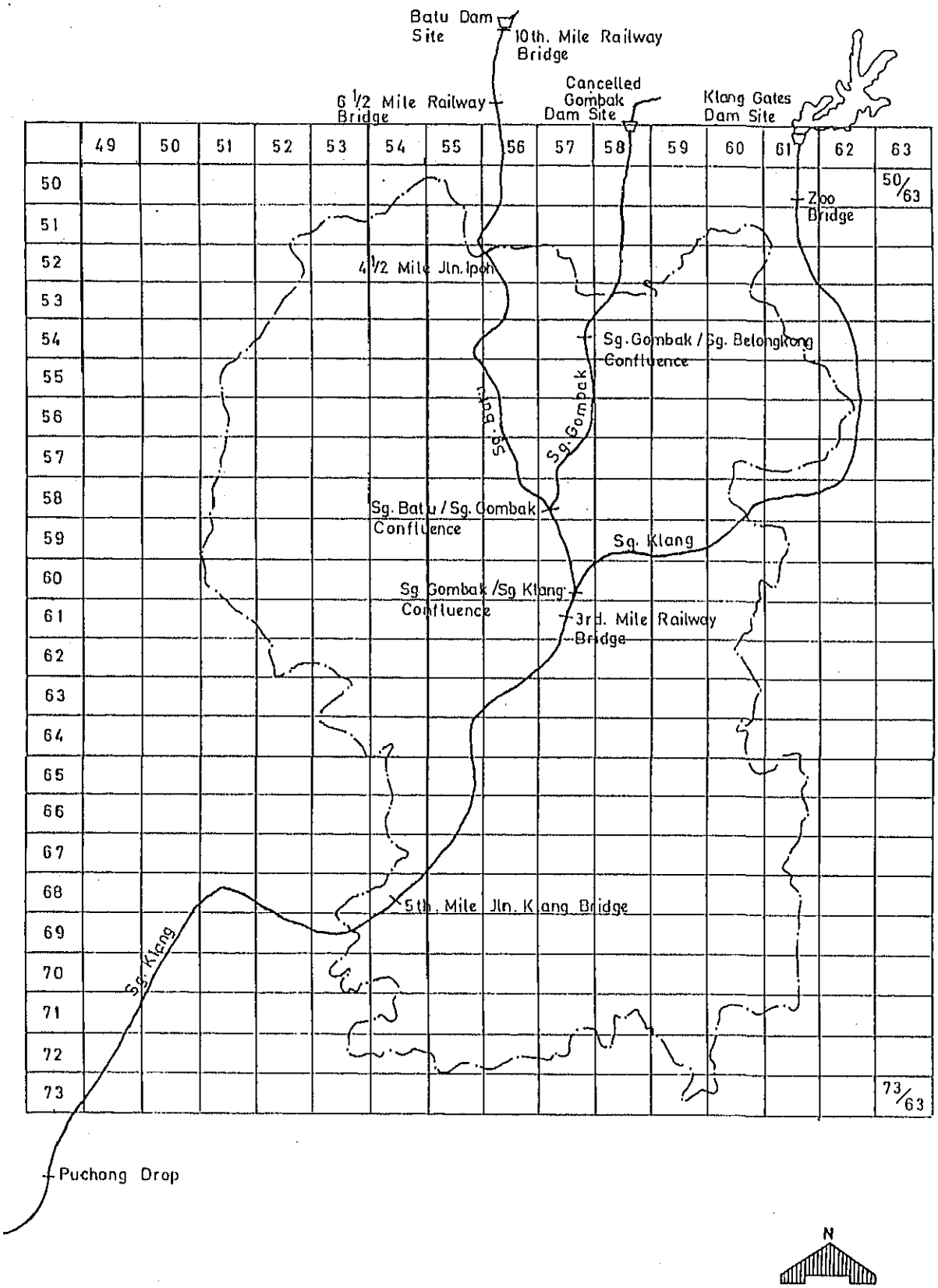

FIG. A-2 INDEX MAP OF TOPOGRAPHICAL MAPS (SCALE 1:1,584)

THE STUDY ON THE FLOOD MITIGATION OF THE KLANG RIVER BASIN

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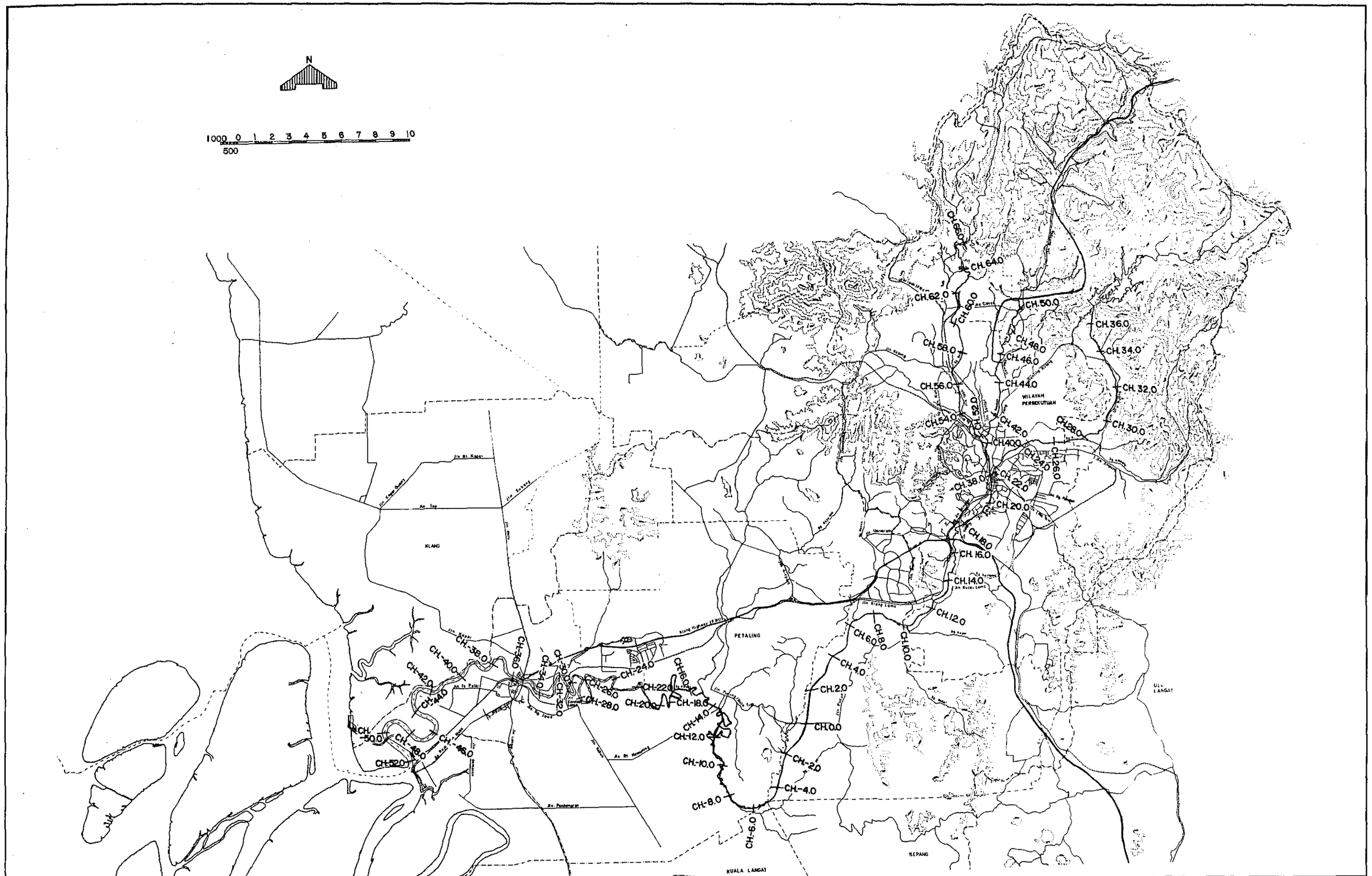

FIG. A-3	LOCATION MAP OF CROSS SECTIONAL SURVEY

THE STUDY ON THE FLOOD MITIGATION OF THE KLANG RIVER BASIN

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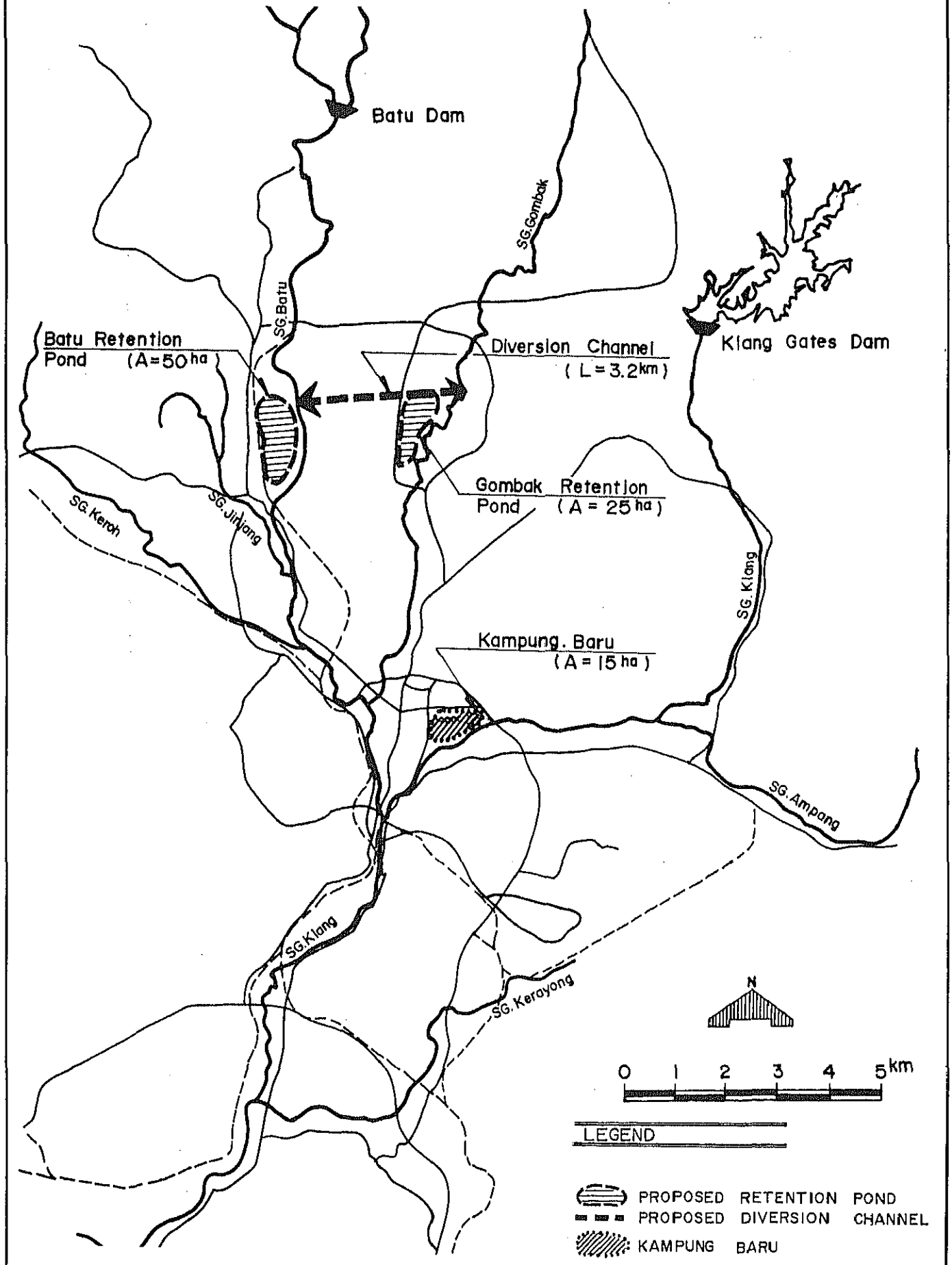

FIG. A--4 LOCATION MAP OF TOPOGRAPHICAL SURVEY FOR THE URGENT PROJECTS

THE STUDY ON THE FLOOD MITIGATION OF THE KLANG RIVER BASIN

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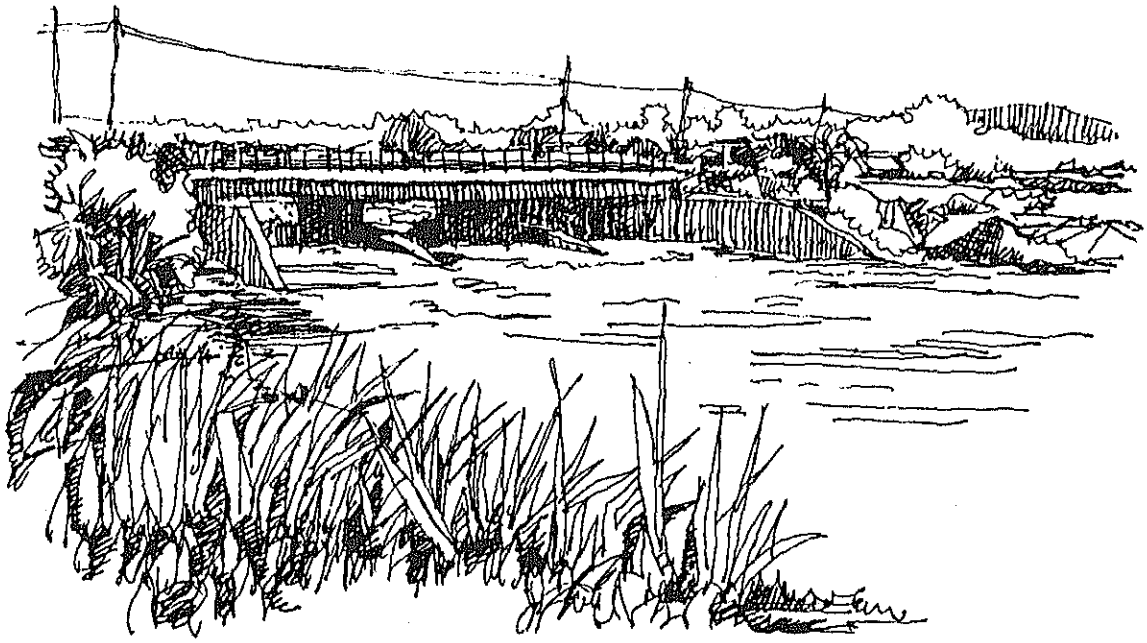
APPENDIX B: METEO-HYDROLOGICAL CONDITION



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APPENDIX B. METEO-HYDROLOGICAL CONDITION

1. INTRODUCTION

The objective of the hydrological study is to define the hydrological characteristics of the Basin and to provide the information necessary for the formulation of the flood mitigation plan. The hydrological study will include the following activities:

- Collection of existing hydrological data
- Assessment of the rainfall and run-off characteristics of the Basin
- Hydrological analysis for an estimation of probable rainfall
- Flood run-off analysis using a mathematical model
- Hydrological and hydraulic evaluation of the flood mitigation works
- Installation of water level gauging station

2. METEO-HYDROLOGICAL DATA

2.1 Meteorological Data

Meteorological data are recorded throughout the Basin by several organizations. Most of the rainfall and evaporation data are collected and published by the Drainage and Irrigation Department (DID), while the collection of data from climatological stations is the responsibility of the Malaysian Meteorological Service (MMS). The National Electricity Board (NEB) operates some rainfall and evaporation stations to gather data for their hydroelectric development projects.

2.2 Rainfall

Since the daily rainfall records within the Basin were obtained at Rumah Sakit Tanglin, Kuala Lumpur in 1879, there exist 55 rainfall gauging stations in and around the Basin as shown in the Table B-1 and Fig. B-1.

Most of these rain gauges are manual type and automatic rain gauges are installed at 14 stations. These stations are densely distributed along the Klang River and its tributaries in the Basin.

Hourly rainfall observation was commenced in 1970 and such 23 stations are installed in the Basin at present.

Daily and hourly data are compiled and stored in the Data Bank of DID, and these records have been published as "Rainfall Records" by DID, Federation of Malaysia.

2.3 Water Level and Discharge

Water level observation and discharge measurements are obtained at 18 gauging stations as shown in Fig. B-1.

Table B-2 shows the observation period of daily/hourly water level and discharge respectively. Data from these gauges have been compiled as "Streamflow Records" showing monthly summaries, maximum, minimum and mean values by DID, Federation of Malaysia.

2.4 Tidal Data

The lower reach downstream from the confluence of Sg. Damansara has gentle river bed slope of around 1/10,000 ~ 1/5,000.

Therefore, the fluctuation of tide water level affects the flood water level along the lower reach.

The tide water level fluctuation is recorded at the Port Klang by Department of Survey and Mapping since 1983.

The location of the observation site is shown in Fig. B-2.

2.5 Sediment Data

The sediment measuring station was constructed firstly at Sentul of Batu River in 1976. Data of suspended sediment concentrations at 8 stations had been published by DID since 1980.

A sediment rating curve showing the relation between discharge and suspended load content is available at 4 stations. However, no observations have been carried out on wash and bed loads up to the present.

3. METEO-HYDROLOGICAL CONDITION

3.1 Climate

The climatic characteristics of Peninsular Malaysia are almost uniform temperature, high humidity and heavy rainfall and the wind over the country is generally light and variable. There are some uniform periodic changes in climate. Based on these changes, four seasons can be distinguished, namely as below.

Seasons	Months
Intermonsoon	Mar. - May
Southwest monsoon	May - Sep.
Intermonsoon	Sep. - Nov.
Northeast monsoon	Nov. - Mar.

Meteorological observations in the Study area have been carried out at Petaling Jaya and Subang Airport. The average values of the characteristics such as air temperature, relative humidity, sunshine hours and evaporation for the latest 15 years is listed in Table B-3.

The recorded mean annual rainfall of the period from 1976 to 1985 in the Basin varies between about 1840 mm at JPT. Klang and 2680 mm at Pemasokan Ampang in the east, 10 km from the center of Kuala Lumpur City.

The seasonal variation of rainfall are shown in Fig. B-3 for 10 stations in the Basin. It indicates that the maximum monthly amount occurs in intermonsoon seasons preceding the southwest and northeast monsoon seasons.

3.2 Meteorological Events in 1987

Generally, in the transition month of October, the low-level wind flow is predominantly westerly. However, for October 1987, the low-level flow was predominantly easterly. This easterly wind interacted with local sea breeze, resulting in huge connective cloud development in the afternoon, bringing severe thunderstorm mostly in Perak, Selangor, Kuala Lumpur and Negri Sembilan.

Meteorological stations in Petaling Jaya and Subang recorded 602 mm and 503 mm of monthly total rainfall respectively as compared to their means of 290 mm and 263 mm. Flash floods were common in low-lying built-up areas.

3.3 Low Flow

Monthly discharge at the water level gauging station of Jln. Sulaiman and Jln. Leboh Pasar in the Klang River, Jln. Tun Razak in the Gombak River, Sentul and Kg. Sg. Tua in the Batu River are shown in Fig. B-4.

As shown in Table B-4, monthly mean discharge at Sulaiman Bridge during the period from April to June and October to December is larger than the annual mean discharge. From this fact, it can be said that the wet season is from April to June and October to December, and the dry season is from January to March and July to September.

3.4 Flood Flow and Rainstorm

According to the flood records at 5 gauging stations shown in Table B-5, 2 large scale floods occurred in January 1971 and November 1972.

(1) 1971 Flood

Kuala Lumpur was hit by a severe tropical depression and experienced widespread flooding on 5th January 1971. The flood damage was very extensive and unprecedented.

In the January 1971 flood, there were three main gauging stations in the Basin. Their locations are as follows:-

- Batu River at Sentul Railways Bridge
- Gombak River at Circular Road Bridge
- Klang River at the Jln. Leboh Pasar Bridge

But they were all affected by the flood water that overflowed the banks, and the gauges were submerged except for the station at Batu River.

Table B-6 lists the maximum water levels recorded at these stations.

Based on the water level difference between Jln. Leboh Pasar and Sentul Railway Bridge, the average flood gradient was about 0.0007 (= 2.05/2840).

(2) Storm Rainfall Pattern and Depth

When the depression crossed the southern part of West Malaysia from January 1st to 5th in 1971, continuous widespread rainfall covered the States of Pahang, Johore, Selangor, Negeri Sembilan and Melaka.

The rainfall at JPT. Ampang on the 1st of January in 1971 amounted to 29.2 mm, the intensity and pattern of rainfall did not vary appreciably on the 2nd and 3rd of January which recorded 38.1 mm and 50.8 mm respectively. On the 4th of January, however, the intensity and pattern changed suddenly and a rainfall amount of 171.5 mm was recorded. This was almost 1.5 times of the total rainfall recorded for the previous three days. Daily rainfall at the stations in 1971 flood is shown in Table B-7.

3.5 Tidal Water Level

The tide is recorded at the Port Klang by Department of Survey and Mapping since 1983.

The various datum relationship at Port Klang is as follows:

Extreme High Water (Oct. 1985)	+4.97 m
Mean High Water Spring	+4.22 m
Mean High Water Neap	+2.91 m
Land Survey Datum	+2.30 m
Mean Low Water Neap	+1.62 m
Mean Low Water Spring	+0.06 m
Extreme Low Water (March 1985)	-0.85 m

(Source: Record Cerapan Air Pasang Surug 1985)

** Note: All values are above Chart Datum Level

3.6 Sediment

According to the sediment concentration records on suspended load in the Klang River at Sulaiman, the annual sediment discharge was about 380 thousand tonnes in 1980.

A rating table of the discharge versus suspended sediment is prepared by DID.

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Table B-1 RAINFALL STATIONS INVENTORY

STATION NUMBER	STATION NAME	GRID REFERENCE	LATITUDE (D.M.S)	LONGITUDE (D.M.S)	DATE EQUIP. INSTALLED		CURRENT EQUIP.		OPER. AUTH.	DATE CLOSED
2914120	LADANG GOLDEN HOPE	VJ809300	02 58 55	101 25 25	1/09		M8		LDG	
2915116	LADANG BUKIT CHEEDING	VJ978228	02 54 40	101 34 35	5/44		M8		LDG	
2916077	LADANG BUKIT HITAM	VK025302	02 59 00	101 37 05	1/14		M8		LDG	
2917001	SETOR JPT. KAJANG	VK223310	02 59 30	101 47 50	4/75	4/75	M8	HW	JPT	
2917106	LADANG WEST COUNTRY BHG. BARAT	VK147293	92 58 35	101 43 40	1/24		M8		LDG	
2917111	LADANG SEDGELEY	VK149267	02 57 05	101 43 50	1/28		M3		LDG	
2918108	LADANG SEMENYIH	VK290267	02 57 10	101 51 30	6/29		M8		LDG	1/79
2918109	LADANG SG. RINCHING	VK298230	02 55 10	101 51 55	6/29		M8		LDG	
3014081	LADANG MIDLANDS	VJ882391	03 03 50	101 29 25	1/08		M8		LDG	
3014083	LADANG HIGHLANDS	VJ831322	03 00 05	101 36 40	1/14		M8		LDG	
3014084	PEJABAT JPT KLANG	VJ831362	03 02 20	101 36 40	9/43		M8		JPT	
3014089	LADANG BUKIT RAJAH BHG. BARAT	VJ827420	03 05 25	101 26 20	1/03		M8		LDG	
3015078	LADANG BUKIT KEMUNING	VJ940322	03 00 00	101 32 30	6/47		M8		LDG	
3015082	LADANG HARON	VJ893335	03 00 50	101 30 05	1/12		M8		LDG	
3016001	PUCHONG DROP	VK001341	03 01 09	101 35 50	1/76	2/76	M8	HW	JPT	
3016075	LADANG BUKIT JALIL	VK074384	03 03 30	101 39 45	1/11		M8		LDG	
3016076	LADANG KINRARA	VK060377	03 03 05	101 39 00	1/14		M8		LDG	
3018107	LADANG DOMINION	VK299339	03 01 05	101 51 55	1/12		M8		LDG	
3115001	LAPANGAN TERBANG SUBANG	VJ949499	03 09 45	101 30 00	10/70		M8		PKM	
3115053	LADANG ELMINA	VJ898535	03 11 45	101 30 15	5/26		M8		LDG	
3115079	PUSAT P. GETAH SG. BULOH	VJ959495	03 09 30	101 33 35	8/42		M8		LDG	
3116001	IBU PEJABAT KAJICUACA MALAYSIA	VK055433	03 06 05	101 38 40	1/74		M8		PKM	
3116004	JPT WILAYAH PERSEKUTUAN	VK102482	03 08 50	101 41 15	4/75	4/75	M8	HW	JPT	
3116005	LADANG EDINBURGH SITE 1	VK045537	03 11 50	101 38 10	4/77	4/77	S8	OTAW	JPT	
3116006	LADANG EDINBURGH SITE 2	VK042522	03 11 00	101 38 00	4/77	4/77	S8	OTAW	JPT	
3116072	RUMAH SAKIT TANGLIN, K.L.	VK107481	03 08 40	101 41 30	1879		M8		JPT	6/76
3117001	EMPANGAN AMPANG (A5)	VK202503	03 10 00	101 46 45	8/70	10/74	M3	HW	JPT	1/77
3117070	PUSAT PENYELIDIKAN JPT AMPANG	VK171492	03 09 20	101 45 00	1/53	10/52	M8	HW	JPT	
3117071	LOJIAIR BUKIT WELD, K.L.	VK123487	03 09 05	101 42 25	1/12		M8		JKR	
3118069	PEMASOKAN AMPANG	VK229495	03 09 30	101 48 05	6/10		M8		JKR	
3118102	SEK. KEBANGSAAN KG. LUI	VK320503	03 10 25	101 52 20	5/70	11/73	S8	EL	JPT	
3215001	R/PAM JKR SG. BULOH PAYA JARAS	VJ916550	03 12 30	101 31 10	7/71		M8		JPT	
3215035	LADANG STARTHAIRLIE	VJ918577	03 14 00	101 31 15	1/22		M8		LDG	
3215051	PUSAT MENGAWAL KUSTA NEGARA	VJ996568	03 13 25	101 35 30	11/27		M8		RS	7/78
3216001	KAMPONG SG. TUA (AB)	VK102620	03 16 20	101 41 10	9/73	9/73	M8	HW	JPT	
3216002	PPH, KEPONG (SEMAIAN)	VK044575	03 13 50	101 36 10	7/73	7/73	M8	HW	JPT	1/74
3216003	PPH, KEPONG (AB)	VK048575	03 13 50	101 38 15	1/76	12/72	M8	HW	JPT	
3216062	LADANG BATU CAVES	VK114582	03 14 15	101 41 55	1/09		M8		LDG	1/76
3217001	IBU BEKALAN KM 16 GOMBAK (AB)	VK148615	03 16 05	101 43 45	12/72	12/72	M8	HW	JPT	
3217002	EMPANGAN GENTING KELANG (AB)	VK174581	03 14 10	101 45 10	11/72	11/72	M8	HW	JPT	
3217003	IBU BEKALAN KM 11 GOMBAK	VK131580	03 14 10	101 42 50	3/74	3/74	M8	HW	JPT	
3217004	KG. KUALA SLEH	VK217608	03 15 30	101 47 25	03/79	03/79	55	HL	JPT	
3217064	JABATAN ORANG ASLI, ULU GOMBAK	VK151644	03 17 35	101 43 55	8/21		M8		JDA	9/77
3217065	LADANG WARDIEBURN	VK159560	03 13 00	101 44 20	1/19		M8		LDG	6/76
3217067	EMPANGAN GENTING KLANG	VK174580	03 14 10	101 45 30	1/32	12/71	M8	KW	JPT	11/75
3218101	STN. JENALETRIK LLN. PONSOON	VK312552	03 13 40	101 53 00	1/54		M8		LLN	
3316028	LADANG SG. GAPI	VK031761	03 23 55	101 37 25	5/70		M8		LDG	
3317002	KM 21 (JPT.) ULU GOMBAK (AB)	VK156660	03 18 30	101 44 10	12/73	12/73	S8	HW	JPT	1/76
3317004	GENTING SEMPAH	VK194725	03 22 05	101 46 15	10/74	10/74	M8	HW	JPT	
3318126	JABATAN PERIKANAN BKT TINGGI	VK255710	03 21 10	101 49 30	10/45	5/65	M8	KW	JPT	4/77
3318127	JANDA BAIK	VK297681	03 19 35	101 51 45	8/48		M8		JPT	
3416025	LADANG BATANG KALI	VK065836	03 28 00	101 39 15	1/14		M8		LDG	
3416026	LADANG RASA	VK008867	03 29 40	101 36 10	1/25		M3		LDG	

Table B-2 BAR CHART OF RECORD

Hourly ——
Daily ——

River Name	Identity Number	Period of Record Available 1910 20 30 40 50 60 70 80	Remark
klang	3116431		
Klang	3116432		
Klang	3116430		
Klang	3117438		
Klang	3117401		
Klang	3117402		
Klang	3217435		
Klang	Klang Gates		
Gombak	3116433		
Gombak	3217401		
Gombak	3217436		
Batu	3216403		
Batu	3116439		
Batu	3116434		
Batu	3116409		
Damanasara	3115437		
Benus	3118429		
Anak	3216402		

Table B-3 MONTHLY METEOROLOGICAL DATA

Item	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Temperature °C (mean)	26.6	27.0	27.3	27.4	27.6	27.6	27.1	27.1	26.9	26.9	26.5	26.5	27.0
Humidity %	78.4	78.9	79.7	81.8	81.1	78.8	79.6	78.6	81.1	82.1	84.1	82.3	80.5
Evaporation mm/day	3.5	3.9	4.0	3.9	3.6	3.4	3.4	3.6	3.4	3.4	3.1	3.0	3.5
Sunshine hours Hour	5.9	6.3	6.5	6.1	6.2	5.5	6.1	5.9	5.2	5.3	4.4	4.7	5.7
Wind Speed m/s	1.0	1.0	1.1	1.0	1.1	1.1	1.2	1.2	1.1	1.2	1.0	0.9	1.1

Station: Petaling Jaya (Lat: 03° 06' N, long: 101° 39' E, Alt: M.S.L. + 45.7m)

Source: Malaysia Meteorological Service

Table B-4 MONTHLY DISCHARGE AT SULAIMAN BRIDGE

(Unit: m^3/s)

Stn. 3116430 CA = 468 km^2

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1973	-	-	-	-	-	-	-	-	-	28.86	30.42	
1974	12.02	11.99	10.11	13.18	20.40	16.07	10.74	7.68	13.58	8.46	13.25	16.83
1975	12.58	16.03	12.09	18.59	12.79	9.33	15.50	9.87	16.48	10.01	15.26	16.07
1976	7.58	6.21	11.01	-	-	11.56	9.59	10.20	11.02	20.96	15.36	11.42
1977	14.10	9.22	7.26	13.56	12.34	15.31	8.38	10.92	10.91	35.96	22.16	13.47
1978	10.17	10.51	10.61	17.33	14.98	9.189	8.11	6.58	6.47	12.78	22.11	11.85
1979	7.83	9.60	7.53	17.39	14.37	14.34	10.37	-	17.00	18.91	15.40	8.29
1980	14.49	15.71	16.06	17.89	20.95	15.88	16.68	15.42	15.49	21.06	21.20	19.23
1981	11.93	12.71	-	-	30.80	13.18	10.73	10.02	-	15.58	15.98	12.46
1982	9.148	11.96	16.09	21.15	21.75	13.13	11.21	11.01	8.50	7.30	-	-
1983	4.13	5.44	8.90	10.38	-	32.50	12.36	18.77	27.93	15.33	16.31	-
1984	-	-	-	-	-	20.22	15.32	-	-	-	-	-
1985	-	36.18	-	-	-	-	-	-	-	-	-	-
MEAN	10.43	10.9	13.58	16.178	18.54	15.04	12.17	11.58	14.15	16.64	18.59	15.56

Table B-5 ANNUAL MAXIMUM DISCHARGE AT 5 STATIONS

Unit : m3/s

River	Klang		Klang		Gombak		Batu		Batu	
C.A. (sq.km)	468.0		464.0		122.0		145.0		55.7	
Location	Sulaiman		Market	Street	Jln.Tun	Razak	Sentel		Kg. Sg. Tua	
I.D. No.	3116430		3116432		3116433		3116434		3216439	
1960			113.31	Nov.07	32.86	Nov.07	38.81	Nov.06		
1961			79.89	Apr.30	19.89	Jul.31	25.21	Feb.25		
1962			85.84	Oct.31	25.92	Aug.26	29.29	Aug.26		
1963			150.14	Dec.03	41.93	Nov.13	41.93	Dec.03		
1964			116.15	Jan.20	41.93	Sep.14	32.44	Sep.08		
1965			121.81	May.10	34.42	May.10	39.26	May.10		
1966			131.62	Jul.12	37.40	Jul.12	39.76	Dec.29		
1967			109.82	Dec.01	33.10	Jun.18	44.83	Jun.18		
1968			104.72	Dec.29	22.00	Dec.29	43.14	Dec.29		
1969			104.72	Oct.24	25.10	Dec.31	42.01	Jun.03		
1970			74.47	Jan.14	23.69	Dec.24	31.86	Jan.06		
1971			667.90	Jan.05	171.90	Jan.05	97.10	Jan.05		
1972			594.48	Nov.25	99.12	Nov.17	43.84	Nov.17		
1973	131.33	Oct.07	191.60	Dec.07	90.19	May.26	70.79	Dec.08		
1974	125.69	Jun.22	148.72	Jun.23	53.34	May.17	56.09	Jun.22	20.96	May.21
1975	165.28	Dec.08			30.15	Dec.08	51.65	Sep.03	14.64	Dec.27
1976	26.11	Jun.05			35.14	Oct.17	68.63	Mar.26	31.50	Oct.16
1977	149.44	Oct.08			76.09	Oct.08	72.75	Oct.06	21.15	Oct.08
1978	99.55	Oct.21			22.89	Nov.16	36.36	Nov.20	20.55	Oct.26
1979	80.48	Apr.13			34.16	Jun.08	32.08	Sep.15	23.30	Jun.07
1980	120.16	Oct.16					20.76	Apr.09	39.48	Jul.26
1981	175.53	May.25					91.01	Sep.08	32.52	Apr.19
1982	196.15	May.01			118.35	Nov.01	93.89	Apr.30	18.52	Oct.15
1983	298.59	Jun.07			58.70	Aug.03	86.34	Jun.13		
1984					46.90	Jan.31	675.90	Nov.17		

Table B-6 MAXIMUM WATER LEVELS IN 1971 FLOOD

Station Name	Number	Water Level
Setul Railway Bridge	3116434	EL 33.834m
Circular Road Bridge	3116433	EL 33.394m
Jln. Lebor Pasar Bridge	3116432	EL 31.232m

Table B-7 DAILY RAINFALL AT THE STATIONS IN 1971 FLOOD

Station Name	Number	January in 1971				
		1st	2nd	3rd	4th	5th
PEJABAT KAJICUACA	3116001	26.2	27.9	41.4	161.3	34.8
JPT. AMPANG	3117070	29.2	38.1	50.8	171.5	30.7
LOJIAIR BUKIT WELD	3117071	36.6	50.8	101.6	103.1	77.2
PEMASOKAN AMPANG	3118069	31.7	43.2	53.3	176.3	48.3
J.O.A ULU GOMBAK	3217064	54.4	37.6	57.9	76.7	36.1
LADANG WARDIEBURN	3217065	15.5	15.7	76.2	91.2	106.2

STATION NUMBER	STATION NAME	GRID REFERENCE
2914120	LADANG GOLDEN HOPE	VJ809300
2915116	LADANG BUKIT CHEEDING	VJ978228
2916077	LADANG BUKIT HITAM	VK025302
2917001	SETOR JPT. KAJANG	VK223310
2917106	LADANG WEST COUNTRY BHG. BARAT	VK147293
2917111	LADANG SEDGELEY	VK149267
2918108	LADANG SEMENYIH	VK290267
2918109	LADANG SG. RINCHING	VK298230
3014081	LADANG MIDLANDS	VJ882391
3014083	LADANG HIGHLANDS	VJ831322
3014084	PEJABAT JPT KLANG	VJ831362
3014089	LADANG BUKIT RAJAH BHG. BARAT	VJ827420
3015078	LADANG BUKIT KEMUNING	VJ940322
3015082	LADANG HARON	VJ893335
3016001	PUCHONG DROP	VK001341
3016075	LADANG BUKIT JALIL	VK074384
3016076	LADANG KINRARA	VK060377
3018107	LADANG DOMINION	VK299339
3115001	LAPANGAN TERBANG SUBANG	VJ949499
3115053	LADANG ELMINA	VJ898535
3115079	PUSAT P. GETAH SG. BULOH	VJ959495
3116001	IBU PEJABAT KAJICUACA MALAYSIA	VK055433
3116004	JPT WILAYAH PERSEKUTUAN	VK102482
3116005	LADANG EDINBURGH SITE 1	VK045537
3116006	LADANG EDINBURGH SITE 2	VK042522
3116072	RUMAH SAKIT TANGLIN, K.L.	VK107481
3117001	EMPANGAN AMPANG (A5)	VK202503
3117070	PUSAT PENYELIDIKAN JPT AMPANG	VK171492
3117071	LOJIAIR BUKIT WELD, K.L.	VK123487
3118069	PEMASOKAN AMPANG	VK229495
3118102	SEK. KEBANGSAAN KG. LUI	VK320503
3215001	R/PAM JKR SG. BULOH PAYA JARAS	VJ916550
3215035	LADANG STARTHAIRLIE	VJ918577
3215051	PUSAT MENGAWAL KUSTA NEGARA	VJ996568
3216001	KAMPONG SG. TUA (AB)	VK102620
3216002	PPH. KEPONG (SEMAIAN)	VK044575
3216003	PPH. KEPONG (AB)	VK048575
3216062	LADANG BATU CAVES	VK114582
3217001	IBU BEKALAN KM 16 GOMBAK (AB)	VK148615
3217002	EMPANGAN GENTING KELANG (AB)	VK174581
3217003	IBU BEKALAN KM 11 GOMBAK	VK131580
3217004	KG. KUALA SLEH	VK217608
3217064	JABATAN ORANG ASLI, ULU GOMBAK	VK151644
3217065	LADANG WARDIEBURN	VK159560
3217067	EMPANGAN GENTING KLANG	VK174580
3218101	STN. JENALETRIK LLN. PONSOON	VK312552
3316028	LADANG SG. GAPI	VK031761
3317002	KM 21 (JPT.) ULU GOMBAK (AB)	VK156660
3317004	GENTING SEMPAH	VK194725
3318126	JABATAN PERIKANAN BKT TINGGI	VK255710
3318127	JANDA BAIK	VK297681
3416025	LADANG BATANG KALI	VK065836
3416026	LADANG RASA	VK008867

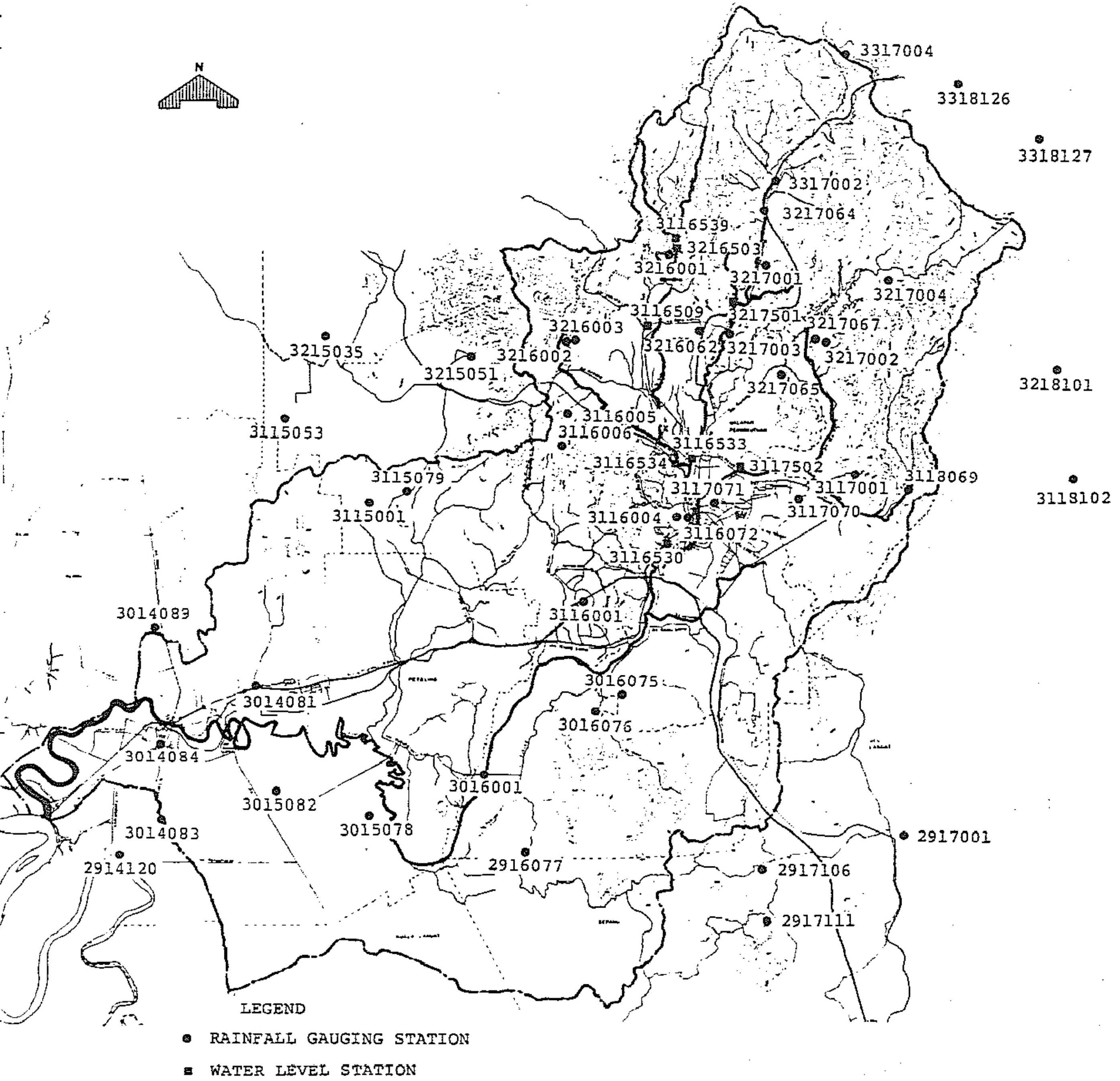


FIG. B-1

LOCATION MAP OF RAINFALL GAUGING STATIONS AND WATER LEVEL STATIONS

THE STUDY ON THE FLOOD MITIGATION OF THE KLANG RIVER BASIN

JICA

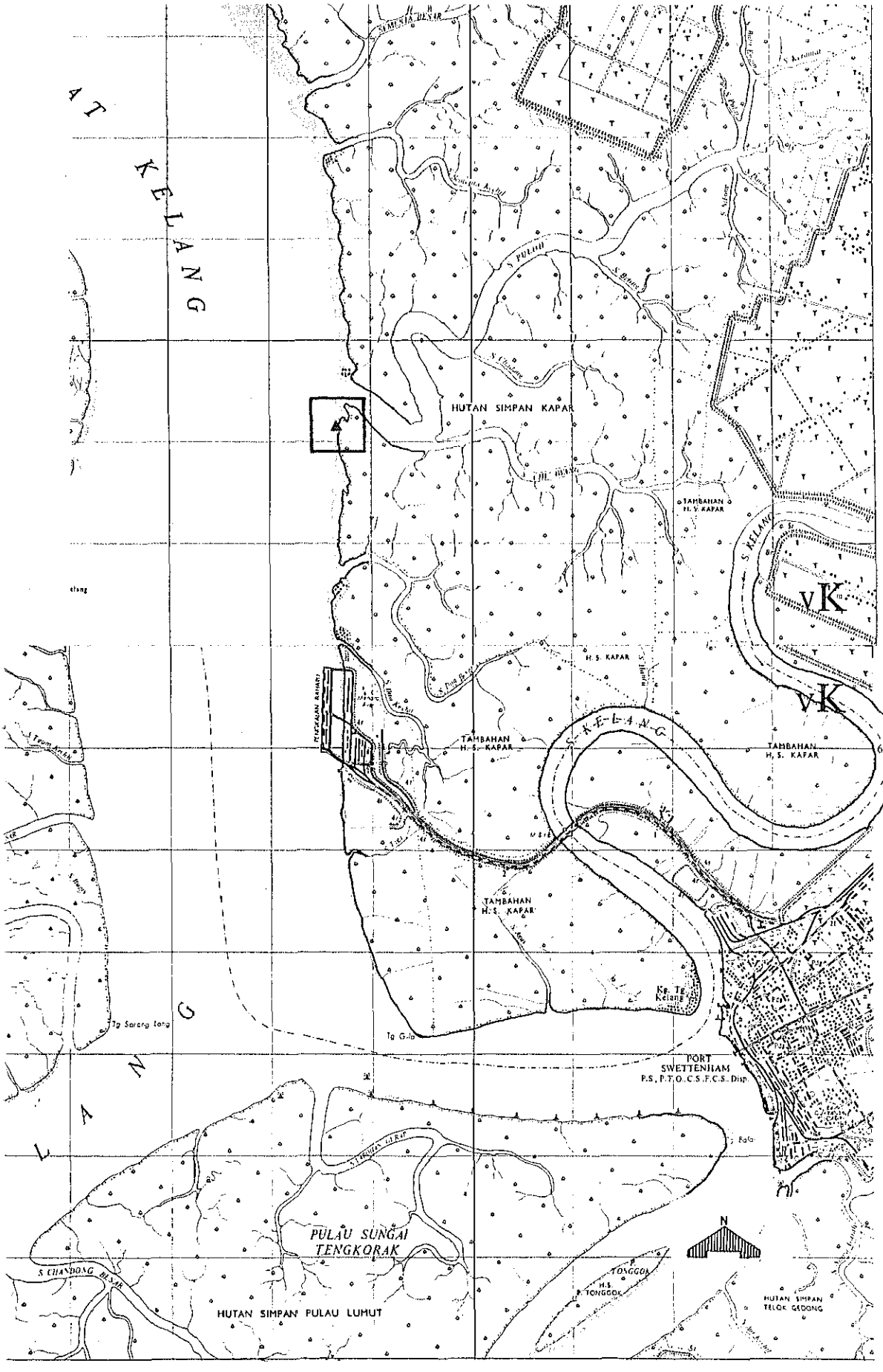


FIG. B-2 **LOCATION OF TIDAL WATER LEVEL STATIONS**

THE STUDY ON THE FLOOD MITIGATION OF THE KLANG RIVER BASIN

JICA

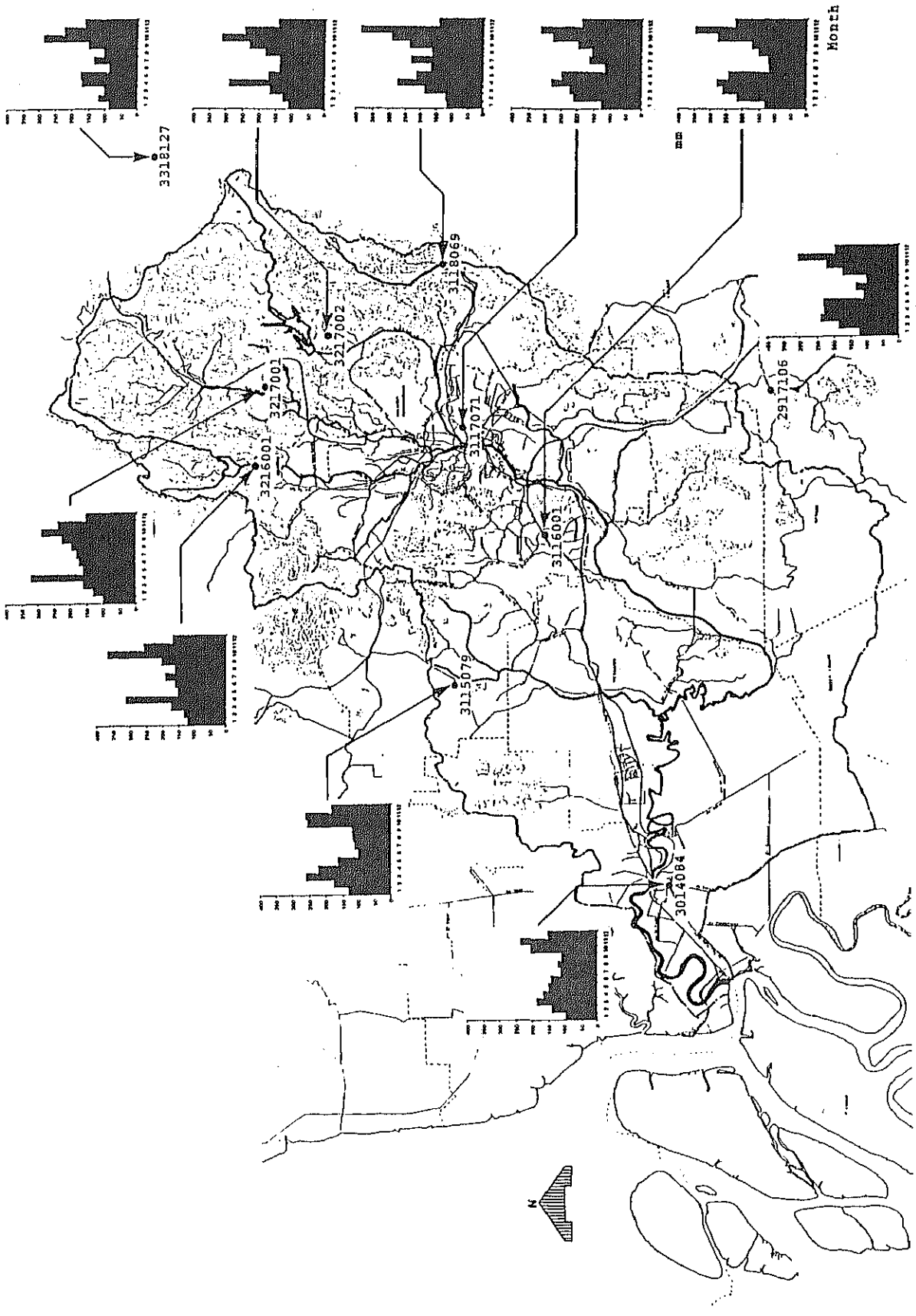


FIG. B-3 MONTHLY RAINFALL PATTERN AT THE STATIONS

THE STUDY ON THE FLOOD MITIGATION OF THE KLANG RIVER BASIN

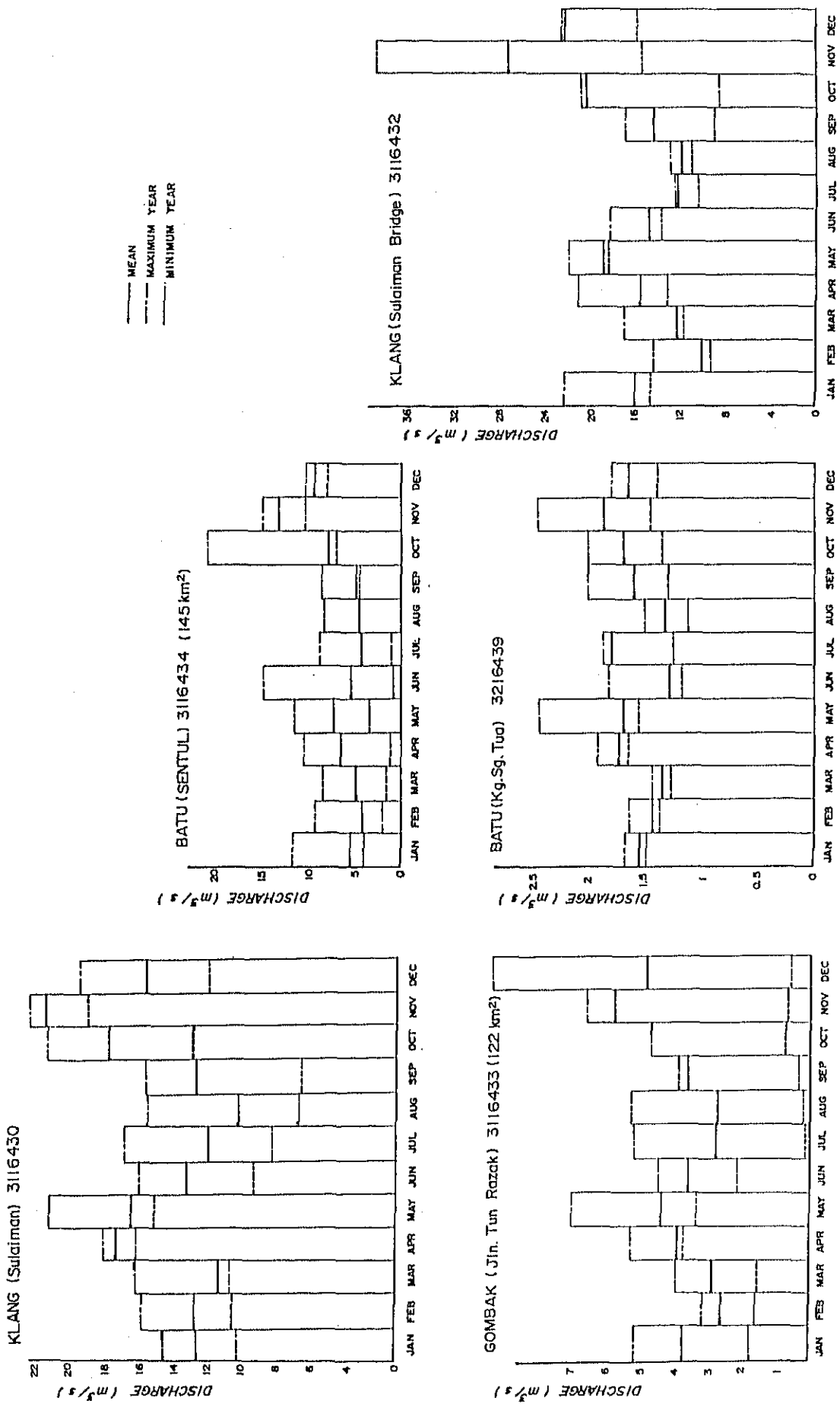
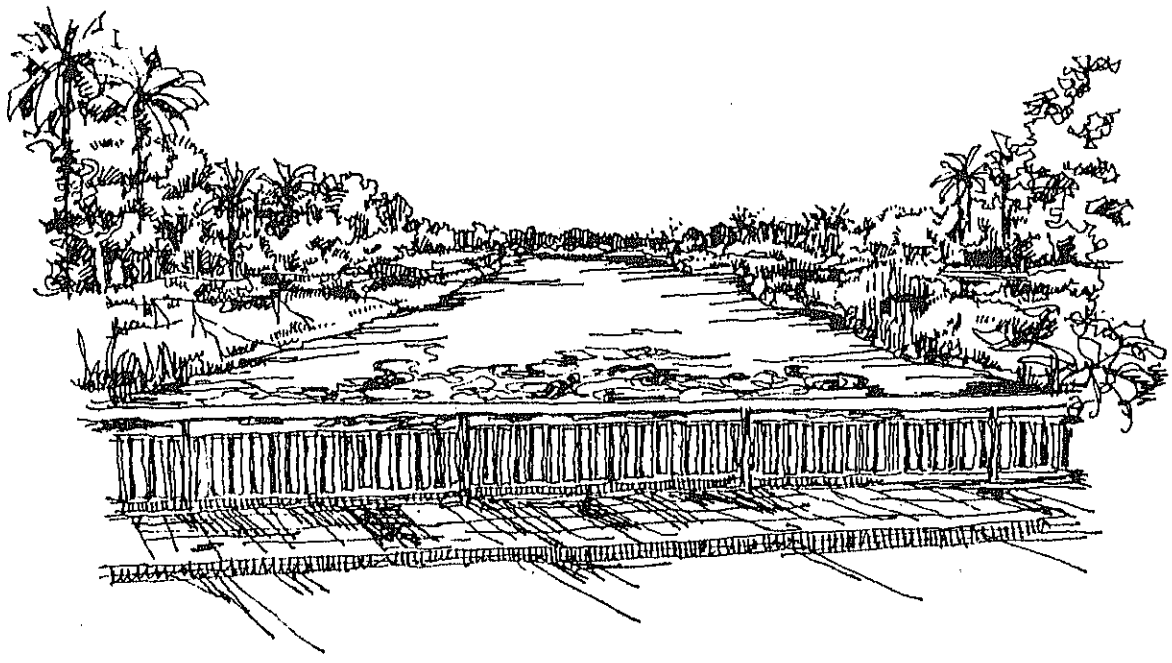


FIG. B-4 MONTHLY DISCHARGE AT 5 STATIONS

THE STUDY ON THE FLOOD MITIGATION OF THE KLANG RIVER BASIN

APPENDIX C: TOPOGRAPHY AND GEOLOGY



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APPENDIX C. TOPOGRAPHY AND GEOLOGY

1. INTRODUCTION

The geotechnical study includes: (i) an investigation of the geological conditions of the Klang River Basin, and (ii) an investigation of the geotechnical conditions along the Klang River and its tributaries as well as the proposed retention ponds and diversion channels.

The investigation of the geotechnical condition of the river basin was conducted by means of surface inspections together with aero-photo interpretations. The investigation of geotechnical conditions of the sites are performed by surface site inspections together with analysis of the collected data.

Geological investigations such as test drilling and pitting are not performed for this study, therefore, all the geological and geotechnical information are based on the site reconnaissance and existing data.

2. TOPOGRAPHY

2.1 Regional Topography

Peninsular Malaysia is characterized by mountain ridges of varied sizes separated by intervening valleys running from northwest to southeast. The ridges are primarily composed of granitic rock and feature peaks of around 2000 m MSL. The largest ridge named the "Main Range" forms a cordillera for the Peninsula. The valleys between the ridges are strongly folded pre-tertiary sedimentary rocks.

Rivers and major tributaries feature steeply sloping sides, numerous waterfalls and rapids, and run primarily parallel to or traverse the ridges.

Other areas on the Peninsula are characterized by monadnocks, or isolated limestone outcroppings which feature precipitous cliffs above surrounding alluvial plains.

Extensive deposits of unconsolidated to semi-consolidated gravel, sand and clay are distributed in the coastal lowlands and floors of some inland valleys. (Fig.C-1)

2.2 Topography of the Study Area

The study area is located in the southwestern coast of Peninsular Malaysia and covers the entire Federal Territory of Kuala Lumpur and parts of the state of Selangor. (Fig. C-2, Fig. C-3)

Undulating features are predominated in the northeastern, eastern and western edges of the basin with prominent landmarks such as G. Sempah (EL. 1197.3 m), Bt. Rapin (EL. 1333.6 m), Bt. Chenuang (EL. 815.2 m) in the north as well as east and Bt. Ulu Gombak (639.9 m) and Bt. Langong (EL. 571.8) in the west.

The Klang River (with a 120 km main stream) originates in this hilly terrain and flows roughly in a southern direction. It is fed by several tributaries before reaching the center of Kuala Lumpur, which is located at its confluence with the Gombak River, at an elevetion of about 30 m above sea level.

The river then meanders in a general westerly direction through a low lying plain between the Kuala Lumpur city center to Port Klang which is located at the mouth.

The geomorphological land classification map of the basin is shown in Fig. C-6. The gradient of the river bed is steep in its upper reaches and mild in the rest of the reach, changing abruptly where the hilly terrain meets the plain.

This peculiar topographic condition causes a rapid change in flow velocity between the steep slope of upper reaches where the flow velocity is very high, and the mild slope of lower reaches where the flow velocity is rather low. This results in an inadequate flow capacity in the plain during the rainy season.

3. GEOLOGY

3.1 Regional Geology

The Malay Peninsula is composed of various types of bedrock reflecting changes in sedimentary environments from Late Cambrian to the Quaternary period. (Fig. C-1)

The Peninsula is a part of Craton, or an already stabilized land mass, of Sunda Shelf, which was tectonically active up to the end of the Mesozoic era and can be divided into three structures, namely the west, east, and axial zones lying parallel to its axis.

The regional strike is sinuous, but runs in the general direction of north to south in the western zone, and in a rather uniform direction of north to south in the axial zone.

The Lower Paleozoic rocks were metamorphosed prior to deposition of the Upper Paleozoic sediments.

The upper Paleozoic sediment occupies two distinct tracks, one on the west of the Peninsula, the other on the east. In the center, most of the Upper Paleozoic rocks are buried beneath the Lower Mesozoic deposits.

Upper Paleozoic and Triassic rocks were tightly folded generally along a north to south axis by a major orogenic phase in the Late Triassic.

The Upper Paleozoic rocks were metamorphosed generally but the Triassic rocks did not suffer regional metamorphism.

Succeeding the Late Triassic orogeny, a long period of erosion, repeated uplift and rejuvenation of granite intrusion occured .

This was accompanied by a molasse type sedimentation in continental basins associated with normal faulting and local volcanism.

There is no record of Lower Tertiary sediments.

Major faults was developed in the Peninsula in response to large scale earth movements in Indonesia and the formation of the Sunda Arc during the Neogene period.

Some small sedimentary basins with coal appear to be localized in depressions aligned with major faults.

Apart from soils and residual deposits, the Quaternary of the Malay Peninsula includes extensive deposition of unconsolidated to semi-consolidated gravel, sand and clay occupying the coastal lowlands and the floor of some inland valleys.

In addition to these sediments and residual deposits, the Quaternary of the Peninsula includes a few occurrences of ryolitic volcanic ash and two occurrences of basaltic lavas that appear to be of possibly early Quaternary origin. (Fig. C-2)

3.2 Geology of the Study Area

The geology of the study area consists of lower to upper Paleozoic {Hawthornden (schist, phyllite), Kuala Lumpur (Limestone, Marble), Kajang (schist, phyllite), Kenny Hill (quartzites, phyllite, shale, sandstone)} formations as well as lower Mesozoic granitic intrusion and Cenozoic alluvial formations distributed along the river and low plains covering the bedrock formations.

The bedrocks are highly weathered in the tropical climate and weathering varies widely reflecting on the differences in geology of the area.

The granitic intrusion of the batholith which underlie most of Peninsular Malaysia and resistant portions of the bedrock form ridges and hills. (Fig. C-4, Fig. C-5)

The stratigraphy of the study area is shown as follows.

Geological Age	Formation	Lithology
Quaternary	Alluvium	Sand, Silt, Gravel
Mesozoic or Younger	Granite and its differentiate	Granite, Pegmatite
Permian Carboniferous (perhaps Triassic)	Kenny Hill	Quartzite, Phyllite Shale, Sandstone
Middle-upper Silurian (perhaps Devonian)	Kajang	Schist, Phyllite
Middle-upper Silurian	Kuala Lumpur	Limestone, Marble
Middle-upper Silurian	Hawthornden	Phyllite, Schist

The various metamorphic formation of the study area represent erosion remnants of the formations which covered the area before the granitic intrusion which forms the central core of the Peninsular Malaysia.

Therefore, the bedrock formations show considerable folding and contortion due to the original metamorphism and additional granitic intrusion.

Kuala Lumpur Limestone

Kuala Lumpur Limestone is a massive bedded limestone with dolomitic lenses and metamorphic marbles.

In view of the highly soluble nature of the limestone, the bedrock is deeply weathered and less soluble dolorite and marble form hills and prominences.

Many fractures and joints due to the folding and faulting may have accelerated the solution of the underlying limestone producing undulating subsurface features of considerable depth in comparison with the other bedrock formations.

Kenny Hill Formations

The Kenny Hill Formation which is the youngest bedrock formation except the granite and the least metamorphosed consists of quarzites, phyllite, shale and sandstone.

Due to the variable character of the original sedimentary formation and the degree of metamorphism, some portions such as quartzites are more resistant than the others and form hills.

Granitic Intrusive Rocks

The intrusive granites consisting of granite, and vein quartz form ridges and hills.

Alluvial Formations

The alluvial formation comprising clay, sand and gravels which partially cover the bedrock formations and form the plains along the rivers.

The alluvial formation can be divided into two parts: natural and disturbed due to mining.

The alluvial formation in the natural state is more clayey and dense or stiff, while, that in the disturbed state is sandier and looser.

Differentiation of soil (which is composed of highly to completely weathered bedrock) and alluvium is difficult in some areas because of the deep weathering of the underlying bedrock.

Thickness of the weathered portion of the bedrock varies from place to place as determined by the regions.

In general, the thickness of the weathering is more than 30 m on undulating to flat areas and relatively less on hilly areas.

4. GEOTECHNICAL CONDITIONS OF THE STUDY AREA

4.1 The Klang River and its Tributaries

Geotechnical condition of practical importance for river improvement work is generally of such superficial zones as alluvial deposit and upper parts of bedrock which are usually weathered. While the alluivial deposit forms a geotechnical zone independent from the underlying bedrock, the magnitude and depth of weathering in the upper parts of the bedrock depend largely upon lithological characteristics of the bedrock itself, as well as upon topographic settings.

Alluvial Deposit

The alluvial deposit includes all particle sizes from clay to gravel. It's undisturbed condition seems to be tight or dense, often showing more than 20 of N-value (number of blows in standard penetration test) according to an existing report. The deposit in the disturbed area is often loose sand of arkose origin, washed away with fine material contents in the time of tin exploitation, and shows N-value of 5 in average in the said report. The sand of the disturbed deposit is highly pervious, with permeability coefficient more than 1 x 10 -1 cm/sec as estimated from its particle size distribution.

While the alluvial deposit froms small plains of width around one kilometre and narrow flood plain along the river channel in the middle

to upper reaches of the Klang river, a relatively wide alluvial plain among hills is developed upstreams of the confluences of two major tributaries of the Batu river and the Gombak river. The deposit consists of granular fine to coarse sand in general.

It should be noted that the disturbed alluvial deposits in old tin mines are often underlain or intercalated with soft mud layers, which may cause large consolidation settlement under newly constructed structures.

Thickness of the alluvial deposit varies, often being more than 10 m.

Bedrock

A weathered zone of the bedrock seems to crop out occasionally on the river banks in the hilly area of steep slopes. It is, however, often difficult to distinguish intensively weathered bedrock from the alluvial deposit.

The relatively wide alluvial plain in the upper reaches of the Klang river, mentioned above, is underlain by limestone bed, named Kuala Lumpur Limestone. Buried surface of the limestone is badly rugged, probably because of karstic solution.

The geotechnical significance of the bedrock in the river improvement work is almost solely for foundation of sheet piles or bearing piles, and, in this aspect, almost all the bedrock, if intensively weathered, will be a satisfactory foundation. Only the irregular shape of the bedrock surface, as mentioned above, may cause some troubles in construction work, but the trouble is not expected to be serious.

4.2 Retention Pond

Ex-mining ponds are being planned for use as the retention and sedimentation pond in the lower reaches of the Batu River.

The alluvial deposits of sand and silty gravels of mainly granitic origin covering the limestone bedrock in the Klang River basin have been extensively dredged for tin mining. As a consequence of these mining operations, numerous mining ponds dot the landscape within the Klang River basin. The sandy gravels distributed around these ponds have been totally washed of the binding silty organic materials during mining operations. The permeability of this loose (N value is around 5 according to the existing report.) sandy layer is more than $1x10^{-1}$ cm/sec in average and is calculated based on the grain analysis results of existing reports. This gives rise to problems of slope stability when such ponds are used for flood water retention with cyclical rising and drawing down of the water level. The foundation of overflow weir of the sedimentation pond should be treated properly to avoid any substantial water leakage. More detailed investigations should be carried out at the detailed design stage.

However, Peninsular Malaysia is seismologically stable and the nearest possible epicenter of earthquakes is expected in central part of Sumatra which is 300 km from Kuala Lumpur. Therefore, no earthquake of noticeable intensity or acceleration is probable to effect on the project site to cause liquefaction of the disturbed alluvial deposits.

4.3 Diversion Channel

Diversion channel has been proposed to link the Gombak River and the Batu Retention Pond.

The route of the proposed channel almost runs through the alluvial deposits. The slope along the channel should be protected with gabion or counterweight to avoid any slope failures.

5. CONSIDERATION OF EROSION CONTROL

5.1 Erosion Potential in the Basin

(1) Geomorphological Conditions

As mentioned in the chapter 2.1 Regional Topography, the geomorphological condition of the study area is as follows:

The Klang River basin is located in the southwestern coast of Peninsular Malaysia where undulating features are predominant in the northeastern, eastern and western edges of the basin with landmarks such as G. Sempah (EL. 1,197.3 m), Bt. Rapin (EL. 1,133.6 m), Bt. Chenuang (EL. 815.2 m) in the north as well as east and Bt. Ulu Gombak (693.9) and Bt. Langong (EL. 571.8 m) in the west.

The rivers originated from the hilly terrains flow in the steep valleys in the upper reaches and then enter the lowland alluvial plains which is less than 50 m in elevation. The river then meanders in a general westernly direction through a low lying plain in its downstream reach toward Port Klang which is located at the river mouth.

Hence, erosion due to the surface flow is more serious in their upper reaches of hilly terrains than the downstream reaches of the lowland plain. (See Fig. C-6)

(2) Geological Conditions

The geology of the project area consists of lower to upper Paleozoic metamorphic rocks as well as limestone, lower Mesozoic granites and Cenozoic alluvial deposits as mentioned before. The bedrocks are highly weathered under the tropical conditions to become resudial soils from the top.

Textual differences of the parent rocks have a marked influence on the final weathering products.

The weathering of sandstone produces sandier soils than the weathering of shale. The weathering of granite produces sandy or gravelly clays with coarse angular grains.

Alluvial deposits in the project area can be divided into two states such as natural and disturbed due to mining. More clayey and consolidated in the natural state, sandy and less consolidated in the disturbed state. Hence, alluvial deposits of disturbed state are more vulnerable to erosion than those of the natural state. (Fig. C-4, Fig. C-5)

(3) Mechanism of Erosion

Owing to the constant year around high temperature and the abundant availability of water in the tropical zone, chemical weathering predominates in the study area.

The weathered land surface were easily washed away by rains which are typically of the flash type in the tropical region.

In addition to the natural erosion of the land, an insufficient surface water drainage system for urban development projects as well as tin mining activities in the area have greatly accelerated the erosion rate recently.

Tin mining operations have been confined to the plains, while, urban development projects have been carried out in the plains on ex-mining land as well as on hilly terrains.

The erosion of the land surface would not have become so serious even if intense weathering in the tropical zone are taken into consideration, if sufficient control on the surface water drainage system in urban development project has been carried out.

Urban development activities on the hilly terrains are supposed to be a more serious cause for erosion in the area than those the plain.

(4) Erosion Potential

Erosion in the land developing area, especially hilly terrain, is more serious than that in the undeveloped as well as developed area. Erosion potential area can be confined to the developing hilly terrains. The embankment portion of developing and developed lands deems to be a more serious cause of erosion than the cut portion.

In this study, developing and newly developed areas are checked and mapped based mainly on the aerial photos (scale 1:10,000) taken in 1986. The map is shown in Fig. C-7.

According to Fig. C-7, developing areas in the hilly terrains are the upstream reach of the Klang River, Sg. Ampang, Sg. Bunus, Sg. Keroh and Sg. Kerayong.

5.2 Protection of Slope Surface and Erosion Control

Rapid urbanization, especially the large scale housing development works, have striped the ground surface of all its vegetation resulting in severe soil erosion and causing siltation of the river.

Vegetation growth on the slope depends on the soil, the cutting and embankment characters as well as the gradient of the slope. On gentle slopes, grassy vegetations are easy to grow. These act to stabilize the slope by virtue of their root systems with forms a mat to effectively reduce surface erosion.

However, when the gradient of slope reaches approximately 30 degree or more, the condition for vegetation growth becomes poor. Vegetation growths are often seen in patched or spotted pattern, in such a state, erosion by heavy run-off can occur around these vegetation colonies forcing them to be uprooted and fall down to the base of the slope.

In most cases, the embankment slope is poor in soil nutrients resulting in poor growth of the vegetation which normally has a poorly developed root system.

(1) Most Common Erosion Occurrence on the Embankment Slope

The top of the slope is easily eroded when concentrated surface water rushes off down the slope. At these locations there is almost no vegetation. If present, they are in the thinly spread out condition.

At the base of a slope, triangular shaped landslips can often be seen. Such slip marks are normally extensively eroded. Little or no vegetation was observed around the edges of the eroded slip marks.

Well grassed or well vegetated slopes are not easily eroded but steeper slopes are often disturbed by erosion even in the well grassed condition.

(2) Buffer Greenery for Erosion and Siltation Control

Thickets of trees and other vegetation are rarely observed on the bottom slope of the development site. These thickets can serve effectively for erosion and siltation control. The stable vegetation growth of the buffer greenery can function as a control on the extent of erosion from the development site.

Muddy surface water flows down to the buffer greenery zone and the water has to pass through the foliaged vegetations. Most of the muddy and silty particles may be trapped by the thick undergrowth. As a result, only purified water flows downslopes.

The soil on which the vegetation grows is always protected by the root system increasing its resistance to erosion. Most of the development sites lacks sufficient buffer greenery, even narrow strips of vegetation, on the lower reaches of the slope.

Buffer greenery conservation is expremely important when large scale development are to be carried out and much consideration must be given on how to preserve vegetation growth in the buffer zone for erosion control.

(3) Urgent Greenification Need on the Slope at the Development Area for Erosion Control

Embankment slopes are quite easily affected by erosion caused by the running-off of surface water laden with silt. As such, the covering of the slopes with vegetation is a very important operation at initial stages of earthworking. The objective slope must not be steeper than approximately 30 degree to provide a suitable condition for vegetation growth.

Followings are general guidelines on the necessity for greenification of the slope.

- Greenification by planting trees, shrubs and regrassing to yield a thicket of multi-layer vegetation composition, so that a stable condition of the slope against erosion can be achieved.

- Trees and shrubs may be chosen from self fertilizing species for the poor nutrient condition soil of the earthworked slope. In this manner, the slope may be easily carpetted with ground covering plants.

- Part of slope-end should have a sufficient flat space for grass planting, as this space may function as a silt trap. By this means, drainage ditches need not be installed too close to the slope-end.

- Ground cover plants or shrubs shall be planted at inside edge of the top of the slope. The root system of these plants serves to protect the shoulder of the slope from being eroded.

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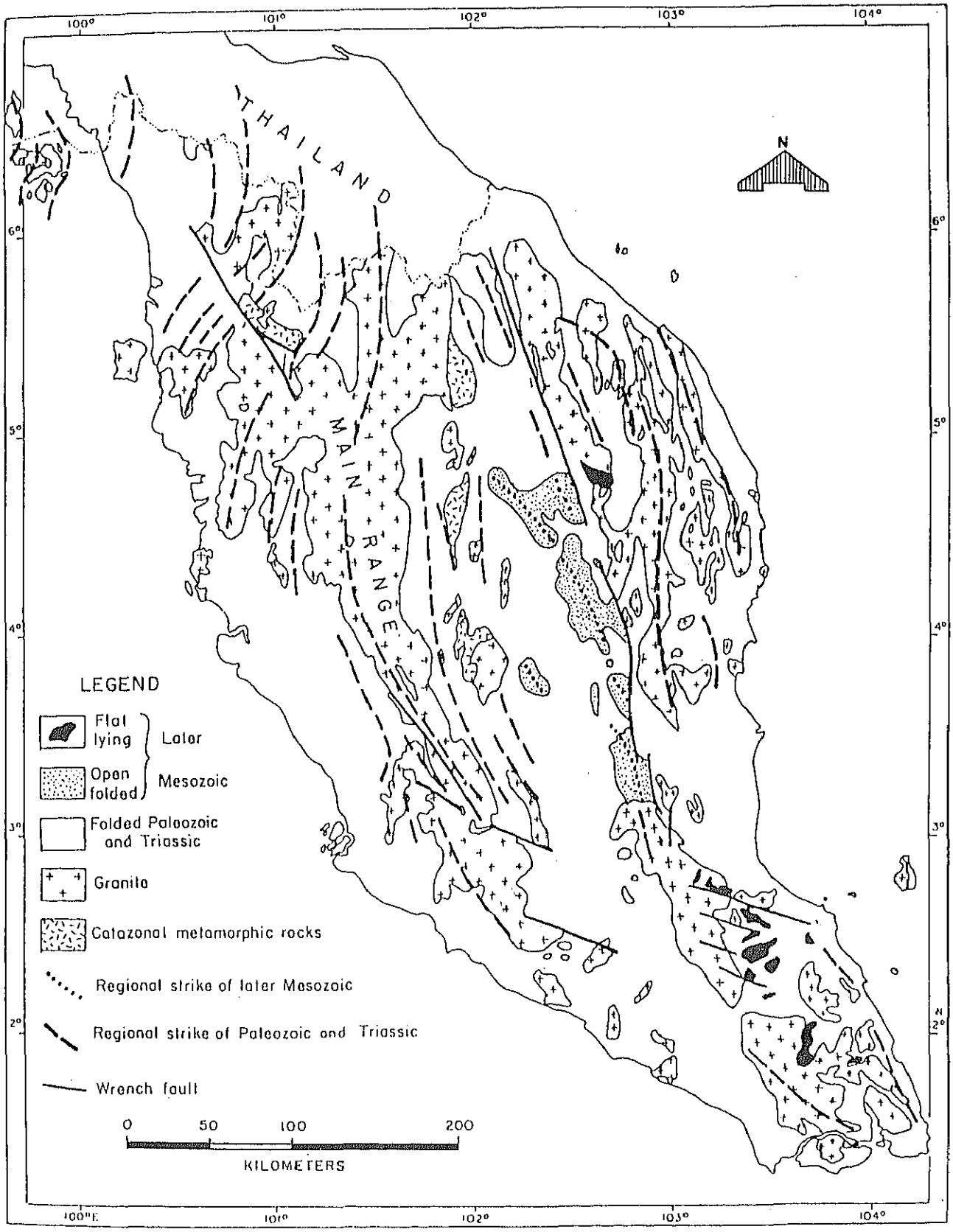

FIG. C-1 STRUCTURAL OUTLINE OF MALAY PENINSULA

THE STUDY ON THE FLOOD MITIGATION OF THE KLANG RIVER BASIN

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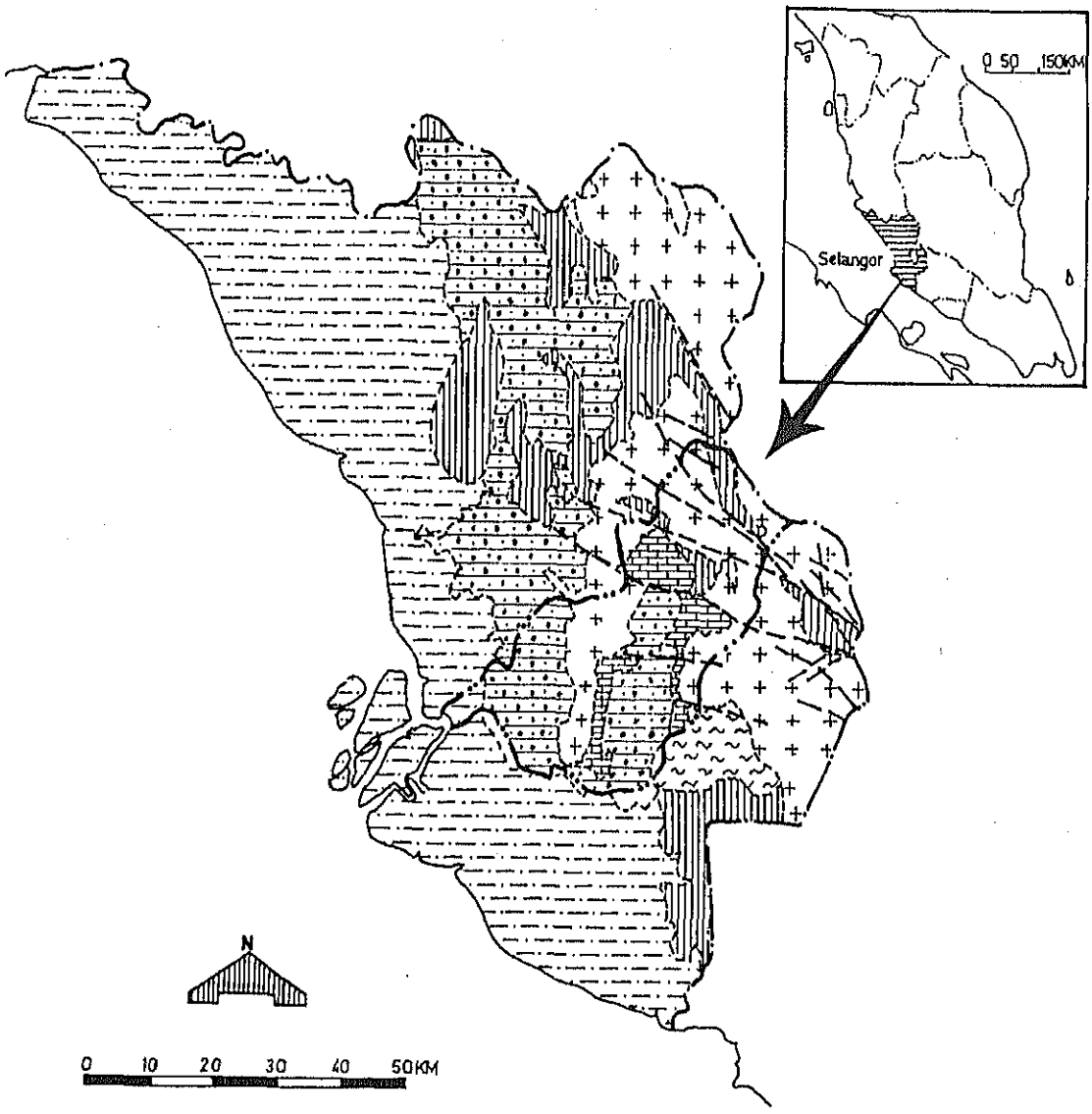

LEGEND

- ALLUVIUM: ESSENTIALLY OF LOOSE CLAYEY - SANDY - GRAVELLY DEPOSITS GENERALLY ALONG THE COASTAL PLAINS, COMMONLY OF EXTENSIVE THICKNESS
- SANDSTONE AND CONGLOMARATE: CONGLOMARATE PREDOMINATE ; WITH QUARTZITE, GREYWACKES, SHALES, SCHIST AND PHYLLITES
- GRANITE AND ALLIED ROCKS: UNDIFFERENTIATED, OFTEN OVERLAIN BY A LAYER OF WEATHERED CLAYEY - SILT MATERIALS.
- LIMESTONE : CRYSTALLINE AND COMPACT, JOINTED AND FRACTURED .
- SAND AND METAMORPHIC ROCKS.
- SHALES PREDOMINATE WITH SANDSTONES, MUDSTONES, AND SILTSTONES, IN SOME AREAS CALCAREOUS AND TUFFACEOUS VARIETIES ARE INTERBEDDED
- FAULT
- STATE BOUNDARY
- STUDY AREA

FIG. C-2 GEOLOGICAL MAP OF SELANGOR STATE

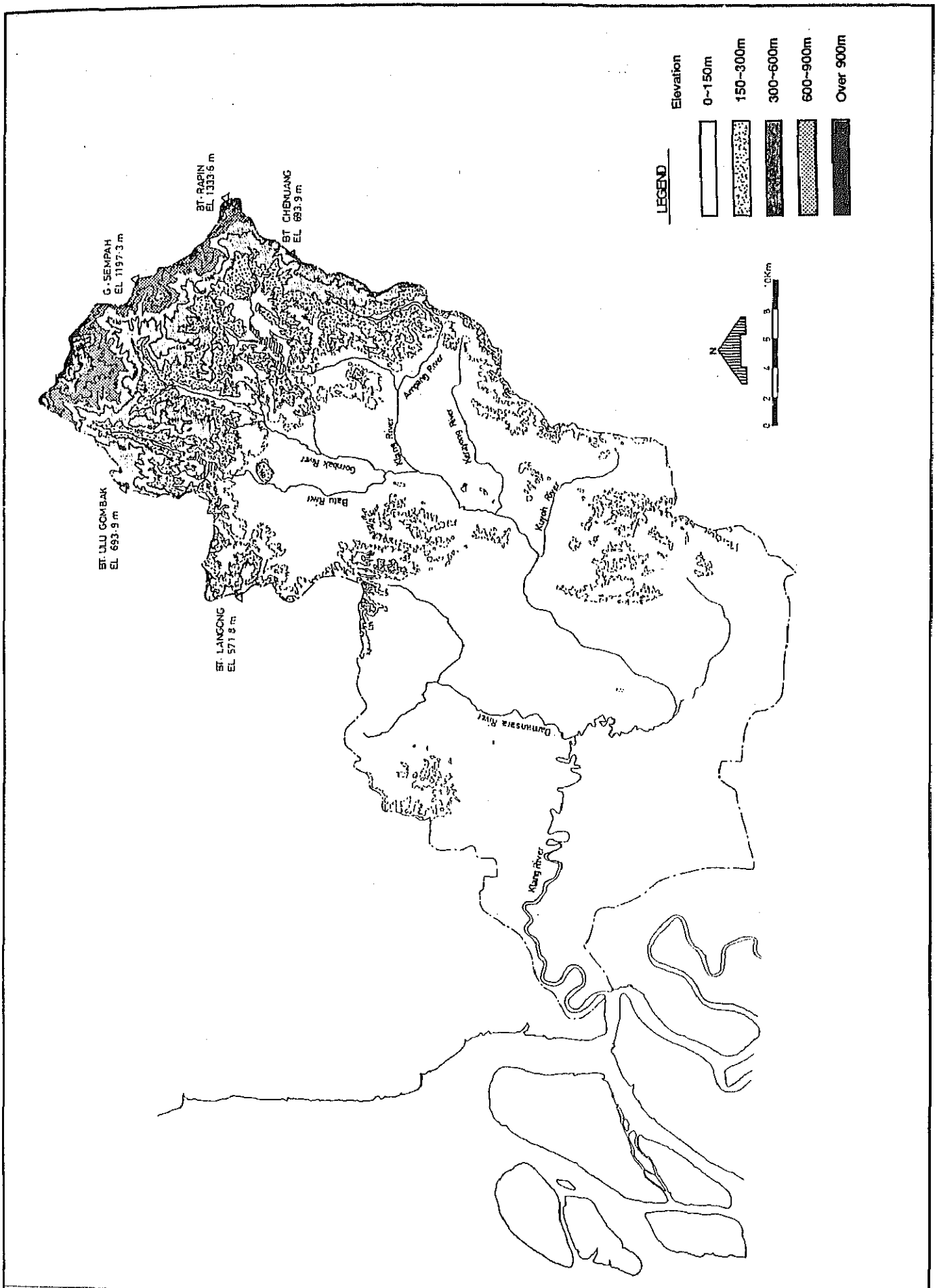

FIG. C-3 TOPOGRAPHICAL MAP OF STUDY AREA

THE STUDY ON THE FLOOD MITIGATION OF THE KLANG RIVER BASIN

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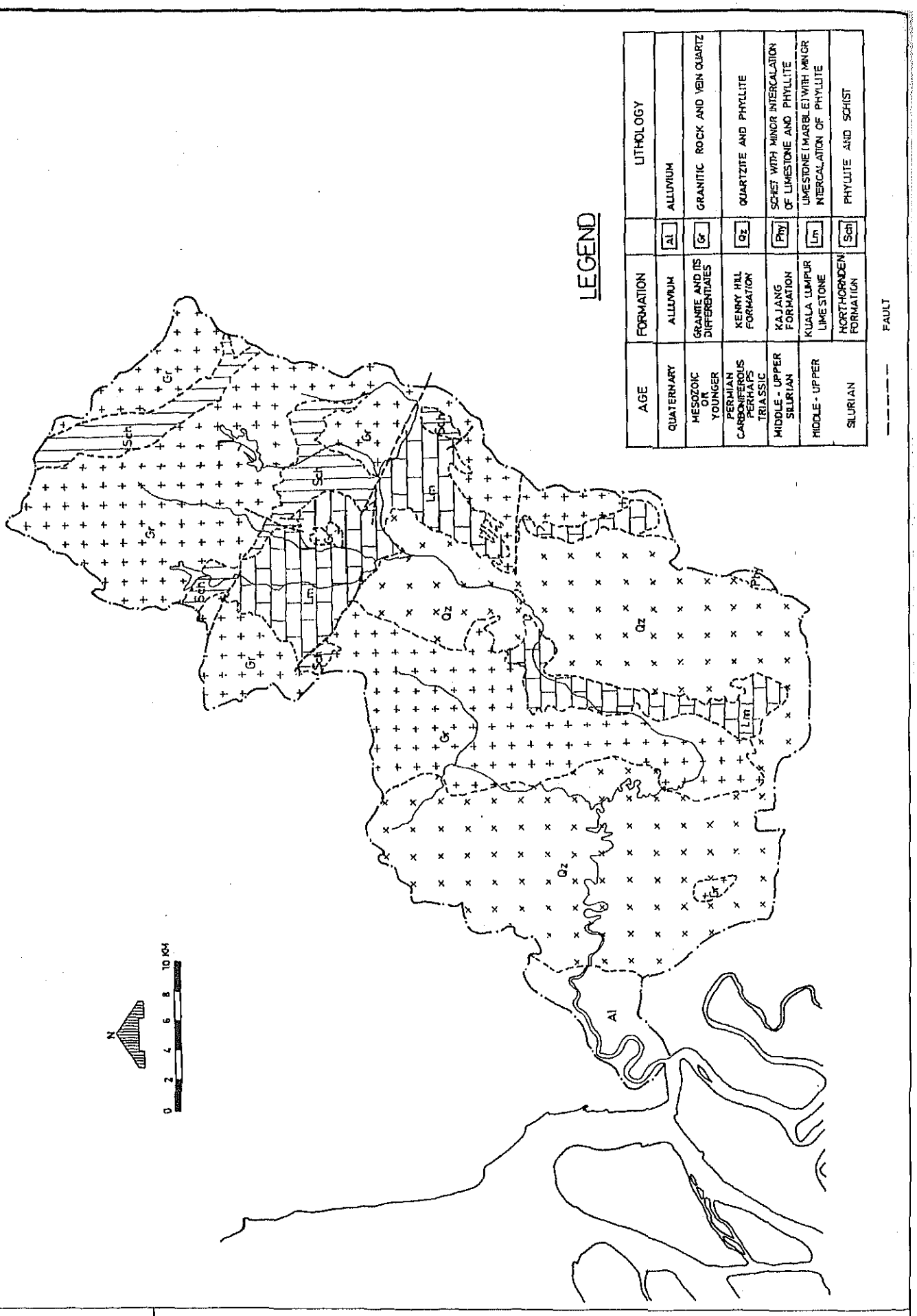

FIG. C-4 GEOLOGICAL MAP OF STUDY AREA

THE STUDY ON THE FLOOD MITIGATION OF THE KLANG RIVER BASIN

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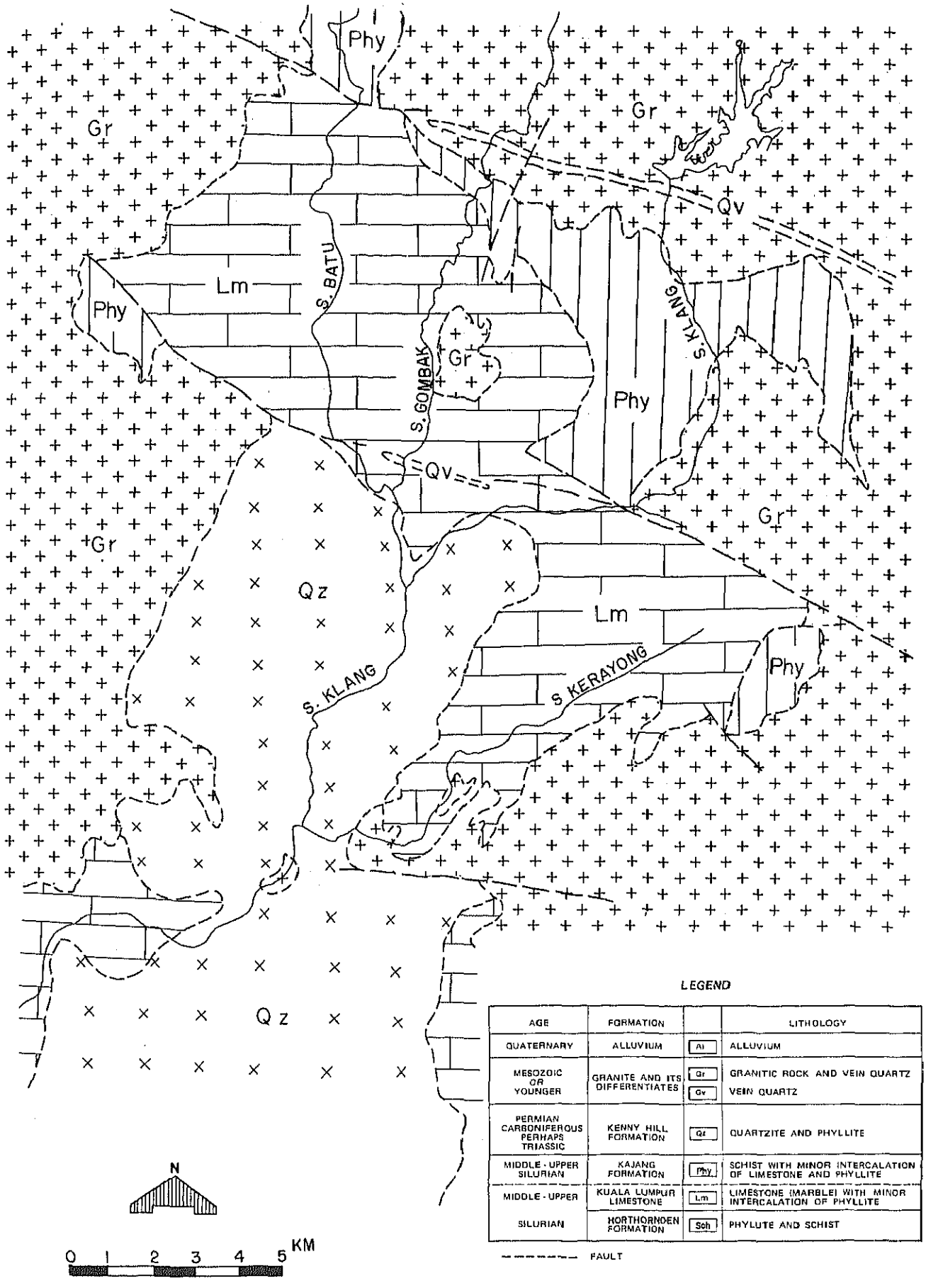

FIG. C-5 GEOLOGICAL MAP OF KUALA LUMPUR CITY CENTER

THE STUDY ON THE FLOOD MITIGATION OF THE KLANG RIVER BASIN

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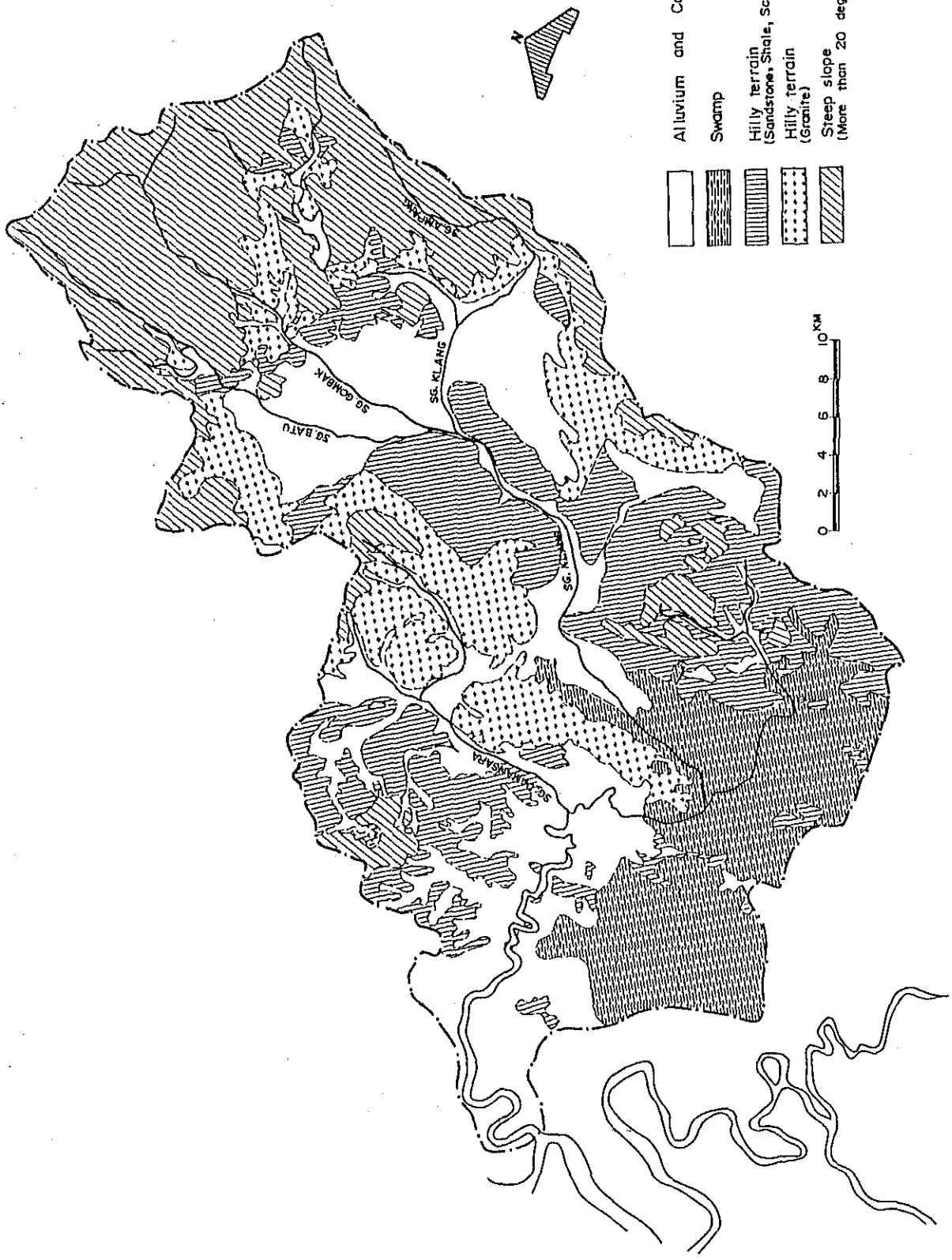


FIG. C-6 GEOMORPHOLOGICAL MAP OF STUDY AREA

THE STUDY ON THE FLOOD MITIGATION OF THE KLANG RIVER BASIN

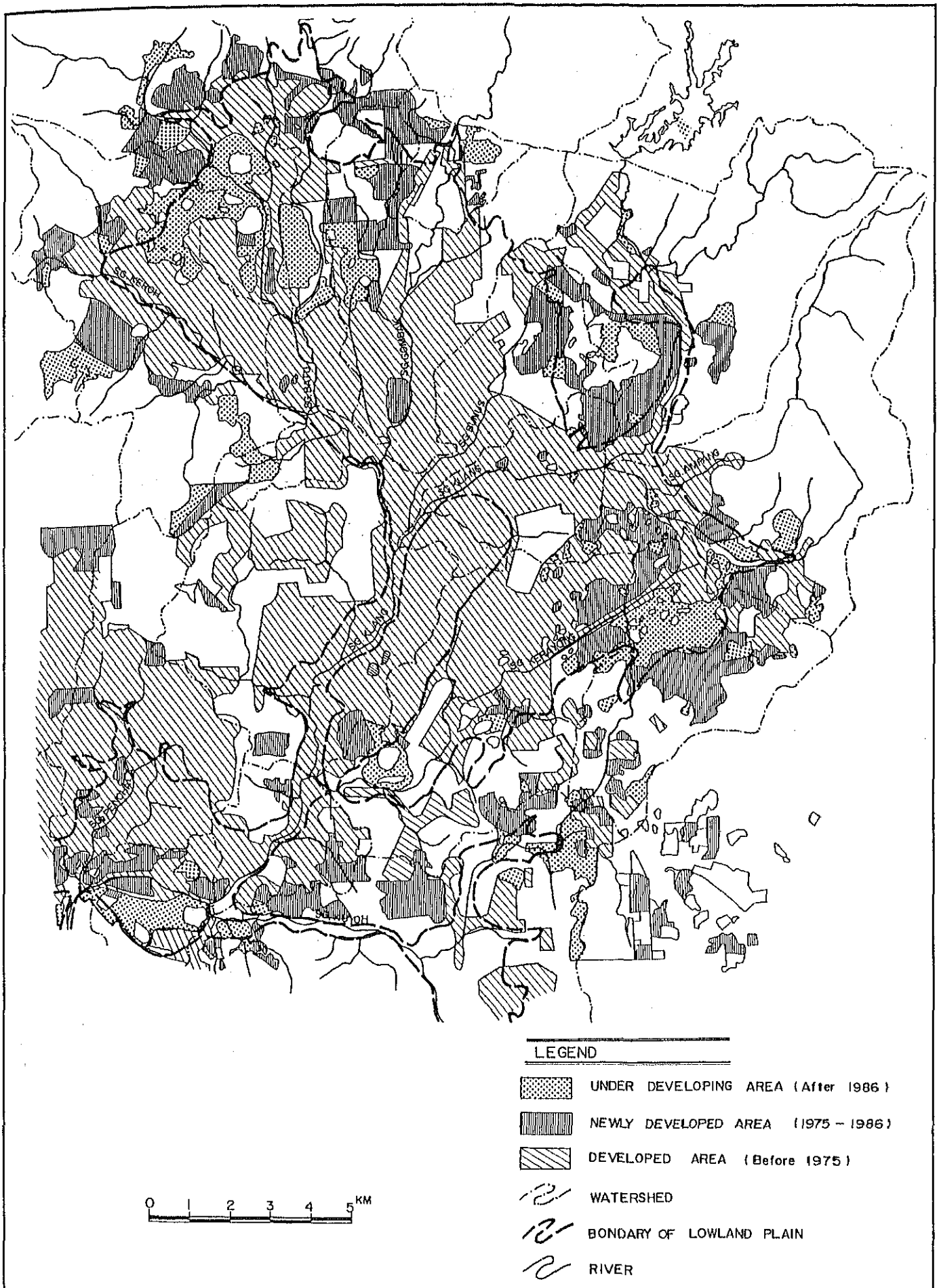
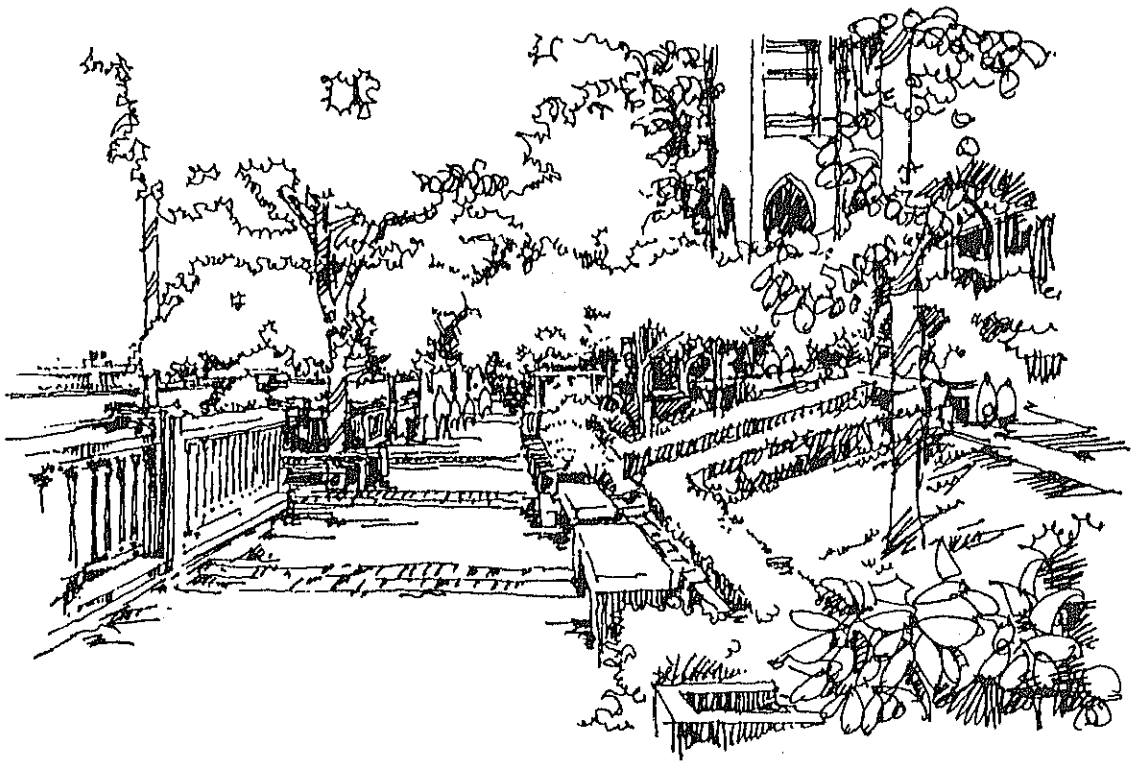


FIG. C-7 NEWLY DEVELOPED AND DEVELOPING AREA

THE STUDY ON THE FLOOD MITIGATION OF THE KLANG RIVER BASIN

APPENDIX D: SOCIOECONOMIC AND LAND USE STUDY



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APPENDIX D. SOCIOECONOMIC AND LAND USE STUDY

1. INTRODUCTION

The objectives of the socioeconomic and land use study is to understand the present and future conditions of the Klang River basin, and to provide the information necessary for the formulation of the flood mitigation plan. The socioeconomic and land use study focuses on the following subjects:

i) Identification of socioeconomic conditions such as administrative structure, population, gross regional product (GRP) and infrastructure in the study area.

ii) Investigation of the rapid urbanization and present land use pattern in the study area including the flood prone area along the Klang River.

iii) Future projection of the socioeconomic conditions and land use pattern on the basis of the existing structure plans and future development plans in the study area.

iv) Consideration of the major land use issues related to the urgent projects of the flood mitigation plan.

2. SOCIOECONOMIC CONDITIONS

2.1 Administrative Structure

The study area, the Klang River basin, is situated in almost the center of Klang Valley Region. It is composed of the Federal Territory of Kuala Lumpur and four major districts in Selangor State: Petaling, Klang, Gombak and Hulu Langat.

Specific areas inside the districts have been designated as local authority areas for development. These local authority areas often contain both Municipalities and District Council areas. In the study area, there are 3 municipalities: Petaling Jaya, Shah Alam and Klang. Shah Alam is the new capital of Selangor State. Administrative structure for the Klang River basin is shown in Fig. D-1.

2.2 Population and Housing

2.2.1 Population Trend

According to the Population Census taken in 1970 and 1980, the total population in the Klang Valley Region has increased from 1.3 million in 1970 to 2.0 million in 1980. The resulting average annual population growth rate in the region was 4.8%, which is considerably higher than the average of Peninsular Malaysia (2.6%). This population of the Klang Valley Region comprised about 18% of the total for Peninsular Malaysia in 1980.

The Federal Territory had a population of 977 thousand or 48% of the total for the Klang Valley Region in 1980. The annual population growth rate during the period from 1970 to 1980 was 3.7% in the Federal Territory, 6.8% in Petaling, 3.6% in Klang, 9.3% in Gombak and 5.5% in Hulu Langat. Among the regions, the growth rates of Gombak and Petaling districts were conspicuously higher than that of the others mostly due to the spill over of urban population from the Federal Territory.

The population density of the whole region was 7.1 persons/ha in 1980, which is higher than that of all Peninsular Malaysia. The population density of the Federal Territory of 40.1 persons/ha, making it the most densely populated area within the whole region. The population trend for the study area is given in Table D-1.

Data on population statistics after 1980 are not officially available. Therefore, the recent population in the study area was estimated by the Klang Valley Transportation Study conducted by the Japan International Cooperation Agency (JICA) in 1987. Referring to

this study, the Klang Valley Region has a population of 2.534 million in 1985, and the annual growth rate during the period from 1980 to 1985 was 4.6%.

2.2.2 Housing Situation

According to the Population and Housing Census in 1980, the housing stock in the Klang Valley Region amounted to 382,000 units. Of this total, the share of the Federal Territory is 46.0%, Petaling 20.9%, Klang 13.6%, Hulu Langat 10.0% and Gombak 9.6% as shown in Table D-2. When this is combined with the population distribution, the Federal Territory and Klang districts showed a higher number of occupants per household than the other districts.

Over 80% of the total housing units were served with electricity by the National Electricity Board (NEB), and over 90% of the total housing units were supplied with piped water by the Selangor Waterworks Department in 1980.

According to the Squatter Census in 1978, the Klang Valley Region had a total of 73,600 units of squatter houses or 19.3% of the total housing stock. There were 40,000 squatter units in the Federal Territory, 22,900 units in Petaling district, 4,000 units in Gombak, 3,600 units in Hulu Langat and 2,200 units in Klang district. There were 319 squatter villages in the Klang Valley Region with a total land area of about 7,200 ha. It is estimated that the total squatter population in the Klang Valley Region was 437,200 or 22% of the total region's population in 1980.

2.3 Gross Regional Product

According to the statistical data in the Fifth Malaysia Plan, Gross Regional Product (GRP) was M$8.971 thousand million for the Federal Territory and M$9.043 thousand million for Selangor State in 1985 at the 1978 price. The total GRP for the Federal Territory and Selangor State amounted to M$18.014 thousand million, which occupied 30.4% of the nation's GDP in 1985.

Among the GRP of the above region, 9.6% was contributed by primary sector, 32.2% by secondary sector and 58.2% by tertiary sector in 1985. For the Federal Territory, the contribution of the tertiary sector such as commercial and service industries accounted for about 80% of its total GRP. On the contrary, the primary sector was only 0.7% of the total GRP in 1985.

The annual growth rate of the GRP during the period from 1980 to 1985 was 7.5% for the Federal Territory and 5.2% for the Selangor State. The growth rate for the Federal Territory was much higher than the national average of 5.8% per annum, but the Selangor State was slightly lower than the national rate. The tertiary sector to GRP in the Federal Territory grew at an annual rate of 8.6% during the same period.

GRP per capita was M$7,783 for the Federal Territory and M$4,963 for the Selangor State in 1985, which correspond to 2.07 times and 1.32 times respectively of the national GDP per capita of M$3,758. This means that the living standard of the above region would be quite high compared with that of other parts of the country.

The GRP by sector in 1980 and 1985 is shown in Table D-3.

2.4 Employment

In the Klang Valley Region, the total employment has increased from 411,400 in 1970 to 889,200 in 1980. The annual growth rate for employment during this period was 8.0%, which was much higher than the population growth rate in the Klang Valley Region (4.8%). 57.7% of the total employment in this region was concentrated in the Federal Territory in 1980 as shown in Table D-4.

Table D-5 shows the employment in the Klang Valley Region by sector. The share of agricultural sector in the whole employment has decreased from 10.9% in 1970 to 4.6% in 1980. On the other hand, the high growth rate in the manufacturing, construction and utilities sectors indicate the rapid progress of industrialization in this region. The share of manufacturing sector reaches to 23.8% in 1980. The share

of the trade and private sectors reaches to 37.4% of the total employment in the Klang Valley Region in 1980.

2.5 Transportation

(1) Road Network

In the Klang Valley Region, there are four major expressways radiating from Kuala Lumpur. Federal Route 1 runs from Kuala Lumpur to the north through Rawang, Federal Route 2 connects Kuala Lumpur to Klang through Petaling Jaya and Shah Alam. The Kuala Lumpur-Seremban Highway in the south and Karak Highway connect Kuala Lumpur to the east coast. The Federal Route 2 lies across the study area from east to west along the Klang River.

The existing road network is classified into expressway, primary and, district distributor, and local road. The total length of existing roads in the Klang Valley Region is about 833 km. Of this, 150 km is expressway, 211 km is primary distributor, 388 km is district distributors and the remaining 84 km are local roads.

(2) Air Transport

The Subang International Airport, located in the Klang Valley Region, plays an important role in international as well as domestic air transportation activities. Its activities are crucial in the national economy.

(3) Sea Transport

Port Klang, located at the mouth of the Klang River, is a focal point of cargo transportation for international as well as domestic shipments. Recently, the new north port has been constructed and serves the surrounding heavy industrial development.

3. PRESENT LAND USE

3.1 Present Land Use in the Klang River Basin

A present land use map for the Klang River basin was based on topographic maps prepared by the Department of Survey and Mapping. Much of the data was taken from the land use map for 1980/81 prepared by the Agricultural Department. Aerial photographics taken in 1986 and recent studies for the Klang Valley Region were utilized to update the map to create the present land use map for the Klang River basin. It is shown in Fig. D-2.

In order to describe the distribution of the present land use, the whole Klang River basin was divided into the three sub-areas: the Upper basin (including the mountainous area in Gombak and the north part of the Federal Territory); the Middle basin (including the south part of the Federal Territory and Petaling Jaya); and the Lower basin (including Shah Alam, Klang and other rural area in Petaling district). The area and composition of land use of these three sub-areas are shown in Table D-6.

Urbanized areas account for 35,430 ha or 27.5% of the whole Basin. Most of these urbanized area are concentrated in the Federal Territory of Kuala Lumpur and the three municipal areas of Petaling Jaya, Shah Alam and Klang, which are located along the Klang River. The urbanized area in the Middle Basin occupies 15,390 ha or over 60% of the total Middle basin area, which has the highest urbanized area ratio compared with the upper and Lower parts of the basin.

The mining areas, with 4,210 ha or 3.3% of total basin area, are scattered around the Federal Territory and the Petaling District. However, these mining areas are mostly ex-mining lands, and there is no active mining land in the Federal Territory.

The agricultural area, with 53,910 ha or 41.8% of the total basin area, consists of mainly rubber and oil palm plantations. Most of the agricultural areas are distributed in the Lower basin of the Klang River.

The forest reserve and swamp area occupies 35,290 ha or 27.4% of the total basin area, which is mostly located on the mountainous region in the Upper basin. Forest reserve and swamp areas are hydrologically very effective for the retardation of surface run-off.

3.2 Present Land Use in Flood Prone Area

The flood prone area for this socioeconomic and land use study is estimated on the basis of the past severe flood damage recorded in 1971. The area covers the Klang River and its several tributaries, namely the Gombak, Batu and Ampang Rivers in the Upper basin, the Kerayong River in the Middle basin and the Damansara River in the Lower basin.

Quantities of land in the flood prone area in the various usage categories was determined with a 1:50,000 scale map. The map was partitioned into a 500 by 500 meter grid as shown in Figure D-3. The derived land use quantities are estimated as shown in Table D-7. The flood prone area covers approximately 18,400 ha which accounts for 14.3% of the total basin area.

The residential area occupies about 3,810 ha or 20.7% of the total flood prone area. Most of it is distributed in the Upper basin, some being occupied by squatter settlements. These squatter settlements are mostly found in the areas along the Klang and Gombak Rivers.

The commercial area in the flood prone area is concentrated in the Federal Territory with an area of 665 ha, which accounts for 82.1% of the total commercial area of the basin. Accordingly, it should be stated that most of the commercial activities in the basin are located within the flood prone area.

The industrial area, with 675 ha or 3.7% of the total flood prone area, is mostly located in Taman Segambut along the Batu River and Salak along the Kelayon River in the Federal Territory.

The institutional and recreational area in the flood prone area occupies 697 ha and 220 ha respectively.

The total urbanized area in the flood prone area amounts to 6,067 ha corresponding to about one-third of the total flood prone area. The remaining areas with about 12,330 ha are undeveloped land such as agriculture, mining and forest reserve.

3.3 Urban Land Use and Urbanization Trend

3.3.1 Urban Land Use for Major Centers

(1) Kuala Lumpur

Kuala Lumpur and its conurbation areas are the largest mass of built-up area in the basin. The built-up areas spread out across the Federal Territory along the major trunk roads. Fig. D-4 shows the existing land use pattern in Kuala Lumpur in 1985.

A summary of current land use pattern in the Federal Territory is presented in Table D-8. Within the Federal Territory, about 57% of the total land area has been built-up, including areas under construction, and a further 17% of the total area committed for future development. The total built-up area will amount to 74% of the whole land area of the Federal Territory.

Commercial and business areas are concentrated in the central area giving form to the Central Business District (CBD), while major industrial areas are located in the northern region of Kepong/Jinjang and in the southern region of Sungai Besi/Salak South.

The squatter areas in the Federal Territory occupy approximately 6.2% of the total land area, amounting to some 1,512 ha, most of which are on government land. These squatter settlements are mainly located in the lowland areas along the rivers and in ex-mining areas. They are generally lacking or deficient in basic infrastructure and makes it difficult to improve river work. According to the existing data from City Hall, the squatter population has been estimated at 243,200 persons, constituting about 23.5% of the total population in the Federal Territory in 1980.

Recent extensive residential development can be seen in the fringe areas of the Federal Territory and in the conurbation areas, especially, in Selayang, Ulu Klang and Ampang/Cheras.

(2) Other Urban Centers

For the development purpose, certain areas have been designated inside the districts under the Local Government Act of 1974. These are Petaling Jaya, Shah Alam and Klang municipality and other district council areas. The existing land use composition for above three municipalities is shown in Table D-9 and their land use characteristics are summarized as follows.

a) Petaling Jaya

Petaling Jaya was originally developed as a satellite town for Kuala Lumpur and is located at about 7.0 km to the southwest from the center of Kuala Lumpur. Within this municipal area, over 90% has been already built up.

Residential land use is the highest at 57.6% and manufacturing industry located along the Federal Highway occupies about 14.9% of the total land area of 4,350 ha.

b) Shah Alam

Shah Alam, the new Selangor State Capital, is not highly developed at present. The main portion of the existing built-up areas are located north of the Klang River. Recently, Taman Sri Muda for housing development and new industrial development are under construction in the south of the Klang River. With the completion of these development schemes, the municipal area of Shah Alam will be expanded to the south of the Klang River with a total area of 13,306 ha.

c) Klang

The municipality of Klang covers an area of 6,082 ha and incorporates the urban area of Klang, Port Klang, Kapar and Meru. The existing town center of Klang is divided into a north and south areas by the Klang River. The built-up areas have been expanding from Klang towards Port Klang along the main trunk road forming an almost contiguous entity.

Klang has been an important industrial center. Recently, the expansion of port related industrial developments has been encouraged in the area adjacent to the north port. The main direction of urban growth is, however, to the south of the municipality.

3.3.2 Urbanization Trend in the Basin

The past urbanization trend in the Klang River basin during the period from 1974 to 1985 is illustrated in Fig. D-5. The urbanized areas during this period were concentrated in the Kuala Lumpur, its conurbation areas and regional corridor along the Federal Highway.

Most of the development in the peripheral areas of Kuala Lumpur has been housing because of good accessibility to the work places and to urban facilities in Kuala Lumpur. Significant housing developments can be seen in Selayang and Ulu Klang in the north, Ampang and Cheras in the

east, Damansara in the west, and Salak Selatan and old Klang Road areas in the south.

Outside the Kuala Lumpur, new development centers can be found along the Federal Highway connecting Kuala Lumpur and Klang. These new developments are concentrated around existing urban centers such as Petaling Jaya, Shah Alam and Klang. In particular, several industrial developments had been carried out in Shah Alam and in Klang municipalities.

Besides the above-mentioned areas, the western part of the Hulu Langat district had been developed into a new university and its related facilities including housing.

4. FUTURE DEVELOPMENT FRAMEWORK

4.1 Existing Development Plan

4.1.1 Regional Development Policy

A future land use policy in the Klang River basin should be formulated and taken into consideration in the existing development plans published by various government agencies.

National and regional development policies in Malaysia are officially shown in the Fifth Malaysia Plan, which are aimed at reducing the economic disparities among the regions. The Central Region including Klang Valley Region is expected to remain as the main generator of growth and to pave the way for the establishment of modern economic activities in the country.

On the basis of the above policies, Klang Valley Perspective Plan (KVPP) was prepared under the Klang Valley Planning Secretariate in 1984. This plan provides the following basic development strategies for the Klang Valley Region over the years from 1990 to 2000.

i Promotion of rapid economic growth by stimulating selected sectors so as not to hinder the goals of achieving balanced development among Regions and States, and realization of the objectives of the New Economic Policy (NEP),

ii Control migration so as to establish a moderate population growth and balanced ethnic composition,

iii Dispersed pattern of settlements and urbanization within the concept of six (6) major growth centers in the Region having their own specific hierarchy and functions as shown in Table D-10.

4.1.2 Existing Structure Plan

For the purpose of providing a long term development goals, objectives, policies and strategies for the urban area, the following two structure plans have been officially prepared in the basin.

- Kuala Lumpur Structure Plan, 1984
- Klang Draft Structure Plan, 1986

In addition, Shah Alam Extension Plan, which is not a structure plan under the Town and Country Planning Act, was prepared in 1983. The structure plan for Petaling Jaya has not yet been completed. A brief summary of these structure plans is given below and target population projection under these plans is shown in Table D-11.

(1) Kuala Lumpur Structure Plan

Kuala Lumpur Structure Plan was approved by the Government in 1984 under the Federal Territory (Planning) Act 1982. The plan proposes the balanced development of Kuala Lumpur through controlled development in the city center and accelerated development of the new growth centers of Damansara, Wangsa Maju, Bukit Jalil and Bandar Tun Razak in the outlying areas.

The plan forecasts a total population in the Federal Territory of 1.55 million by 1990 and 2.20 million by 2000, and the total employment opportunity will be 738 thousand by 1990 and 1,032 thousand by 2000.

By the year 2000, Kuala Lumpur is expected to be fully developed and almost exhausted its land resource.

(2) Shah Alam Extension Plan

The Shah Alam Extension Plan was completed in 1983. The Plan is based on the goal of achieving a State capital that possesses a high level of urban functions. It covers the area extending to the south of the Klang River with 13,306 ha and future city boundary will be formed by the proposed new expressway.

Intensive industrial areas have been planned on the site along the existing Federal Highway and on the east side of the Klang River, called the HICOM project.

(3) *Klang Draft Structure Plan*

The Klang Draft Structure Plan was completed in 1986. The future development concept of the plan is to develop the Meru New Center as a satellite center and encouraging growth to the south of the Klang River.

Klang will continue to function as an important seaport in Malaysia, and the new north port has been constructed and operated recently. Heavy industrial development is planned near the north port and some industrial development will be dispersed to the north of the existing town center.

The plan has projected a total population of 668 thousand by the year 2005 for the Local Planning Authority Area.

4.2 Socioeconomic Framework

4.2.1 Population Projection

The future population in the year 2005 is estimated referring to the following two plans: (1) Klang Valley Perspective Plan (KVPP); and (2) Klang Valley Transportation Study (KVTS).

According to the Klang Valley Perspective Plan, the target population for the Klang Valley Region is projected as 3.3 million in 1990 and 4.8 million in 2000 as shown in Table D-12. The population growth rate is 5.0% per annum during the period between 1980 and 1990, and 3.8% per annum between 1990 and 2000. The growth rate for Shah Alam and Selayang is estimated much higher than that of other urban centers in the Klang Valley Region during the period between 1980 and 1990.

The future population in 2005 is projected by the Klang Valley Transportation Study, which is based on the above target population up to the year 2000 prepared by KVPP. The future population for the Klang Valley Region is estimated to be 5.5 million in 2005. Comparing this projection with the population in 1985, increment of population during 20 years between 1985 and 2005 is 2.9 million in the Klang Valley Region as shown in Table D-13.

The future population within the Klang River basin that includes most of the urban centers in the Region was estimated in this study according to the future land use plan. The population in the Klang River basin is estimated to be 4.7 million in 2005, which occupies over 85% of the total population in the Region. The gross population density in the basin will increase from 17.5 persons/ha in 1985 to 36.8 persons/ha in 2005.

4.2.2 Economic Growth

A future projection of GRP for the Federal Territory and Selangor State, covering the period from 1986 to 1990, was prepared by the Fifth Malaysia Plan in 1986. According to this plan, the annual growth rate

of the GRP is projected at 6.1% for the Federal Territory and at 4.6% for the Selangor State during the period between 1986 and 1990. The annual growth rate for the Federal Territory is higher than the national average of 5.0% per annum during the same period.

On the other hand, the GRP for the Klang Valley Region during the period from 1980 to 2000 is estimated by the Klang Valley Perspective Plan. According to this plan, the annual growth rate of GRP is projected at 5.6% during the period between 1980 and 1985, 6.2% between 1985 and 1990 and 4.3% between 1990 and 2000.

A long term projection for GRP in the Klang Valley Region has been proposed in the Klang Valley Transportation Study in 1987. It is adopted in this study as well and is given below. The estimated GRP for the Klang Valley Region is shown in Table D-14.

- The GDP of whole Malaysia will grow at a rate of 5.0% per annum during the period between 1985 and 2005 based on the assumption that the 5.0% of annual growth rate of GDP will continue unchanged up to the year 2005.

- The percentage share of the GRP for the Klang Valley Region in the GDP of whole Malaysia is expected to increase from 26.1% in 1985 to 31.0% in 2005. The corresponding GRP for the Klang Valley Region is estimated to be M$15,511 million in 1985 and M$48,842 million in 2005 at the 1978 price in monetary terms.

4.3 Future Land Use Plan

4.3.1 Development Direction

A future land use plan for the Klang River basin with a target year of 2005, was prepared taking into account of the existing development plans and framework mentioned before. The following development directions are assumed to provide the future land use pattern of the basin.

i) The future regional development for the Klang Valley Region is based on the concept of six growth centers, namely Kuala Lumpur, Shah Alam, Petaling Jaya, Klang, Bangi and Selayang having its own specific hierarchy and functions as shown in Fig. D-6. Five growth centers except Bangi are included in the Klang River basin.

ii) Since the growth centers of Kuala Lumpur, Petaling Jaya and Klang are already congested, the priority for new development should be given to Shah Alam, Bangi and Selayang. These new growth centers are expected to function as self contained status with sufficient residential, commercial and industrial functions in the future.

iii) The Kuala Lumpur and its surrounding conurbation areas are facing strong development pressures, however its disordered urban expansion should be controlled. Future urban growth will be encouraged toward the south-west, south-east and north-west from Kuala Lumpur.

iv) New development in the part of Kuala Lumpur including Selayang is mostly located in the upstream of tributaries of the Klang River, therefore careful control measures for environmental pollution and soil erosion are required.

v) The forest reserve area located in the upland of the basin should be permanently preserved, because these areas are hydrologically very effective for the retardation of surface run-off from the viewpoint of overall water management in the catchment area.

vi) The southern part of the basin in the Kuala Langat district should be reserved for forest reserve or agricultural field with a function of natural retarding basin so as to mitigate flooding problems of the downstream of the Klang River.

vii) Buffer zones in the form of green area or recreational area should be provided between major growth centers in order to protect from disordered urban expansion and to give public amenity.

viii) Existing squatter settlements located in the lowland areas along the river should be removed immediately because of their serious flooding problems and for implementing river improvement work.

ix) Ex-mining lands in the strategic areas are to be remained as government land and not to be alienated to private developers. because, some of the ex-mining lands should be utilized into recreational area with a purpose of retention pond.

x) Malay Reservation land located near the major urban centers should be planned and developed in line with the overall land use plan.

The future land use plan for the basin is proposed on the basis of these development and planning directions, as shown in Fig. D-7. The future land use plan in the flood prone area is shown in Fig. D-8.

4.3.2 Future Urbanization

The future land use composition for the Upper, Middle and Lower basin of the klang River are estimated on the basis of the future land use plan mentioned before, and it is summarized in Table D-15.

The future urbanized area is expected to be 56,540 ha or about 44% of the total basin area in 2005. Regarding the urbanized area ratio for the three sub-basins, the Middle basin will be urbanized over 80% of the total area, which is much higher than that of the remaining Upper and Lower basins.

On the contrary, the undeveloped rural areas comprising mining, agricultural and forest reserve areas will amount to 72,330 ha or about 56% of the total basin area. Some 18,990 ha or over 70% of the total agricultural area will be located in the Lower basin. The forest reserve or swamp areas will account for 43,440 ha or about 34% of the total basin area, most of which are located in the Upper and Lower basins.

In order to clarify more the past and future urbanization trend in the basin, the urbanized area in 1974, 1985 and 2005 is shown in Fig. D-9. A future extensive urbanization during the period between 1985 and 2005 is expected to be more concentrated in the Lower basin. The urbanized area in the Lower basin will increase from 7,230 ha in 1985 to 17,820 ha in 2005, and most of these increasing urbanized areas will be due to the urban expansion of Shah Alam.

The total population in the basin is estimated to grow from 2.2 million in 1985 to 4.7 million in 2005. The population increase will be absorbed not only in the surroundings of the existing urban area but also in the new growth centers such as Shah Alam and Selayang. As a result, average population density of the urbanized area in the basin will increase from 63 persons/ha in 1985 to 87 persons/ha in 2005.

5. MAJOR LAND USE ISSUES FOR THE FLOOD MITIGATION PLAN

5.1 Development Pressures on Ex-Mining Land

Ponds left from strip mining of tin are quite useful in flood mitigation and for the overall water management in the Klang River basin.

According to the mining data in 1986, the total area of existing mining land amounts to 8,230 ha in the Klang Valley Region, of which 1,370 ha is still in operation while the remaining 6,860 ha is no longer in use. The active mining areas are mostly located in the Petaling district as there is no active mining in the Federal Territory. Table D-16 shows the present mining areas in the Klang Valley Region.

Up to the present, about 4,510 ha of ex-mining land has been developed for urban use in the Klang Valley Region. Most of these developments on ex-mining lands are used for housing and industrial areas and are located in Kuala Lumpur and its surrounding areas due to good accessibility. Fig. D-10 gives the distribution pattern of ex-mining lands including their utilization around the Federal Territory.

There are still about 2,000 ha of unused ex-mining land in the Federal Territory, of which some is already under housing construction. The remaining areas have also been committed for development in the near future.

The changes in the land use pattern of these ex-mining lands have important consequences on the environment. This is because, in the hydrological viewpoint, some of these ex-mining lands with ponds located in the strategic area can play the role of rainwater retention ponds providing certain measures of flood mitigation of the Klang River.

Accordingly, it is necessary to give more attention to the use of the existing ex-mining lands in urban area. Some of these lands in strategic areas are not to be made available to private developers but should remain as government land and utilized as recreational areas with a primary function as retention ponds of flood run-off.

5.2 Planning Consideration for the Proposed Retention Pond

5.2.1 General

For the purpose of the flood mitigation of the Klang River, the Study Team proposed the use of two retention ponds as a protective measure; one is the Gombak Retention Pond located in the rural area in the upper stretch of the Gombak River; and the other is the Batu Retention Pond situated on ex-mining land in the vicinity of the Batu river. This section presents a description of the existing land use and the problems envisaged in the use of these retention ponds.

5.2.2 Gombak Retention Pond

The proposed site of the Gombak Retention Pond has been declared as the Gombak Malay Reservation under the Malay Reservation Enactment of 1913.

The existing land use pattern of the Gombak Malay Reservation is a mixture of residential (Kampung) and agricultural or open space. The area is still rural in nature and is an enclave surrounded by urban development in the Federal Territory and its adjacent area. However, development pressures have been increased by the completion of the Karak Highway.

From the legal point of view, all the land in a Malay Reservation area belong only to Malays and is prohibited from transfer or lease to non-Malays. Development of Malay Reservation land is a sensitive issue undercutting political, legal and social constraints. Therefore in order to develop the Gombak Retention Pond on Malay Reservation land a strong political effort is required.

5.2.3 Batu Retention Pond

The proposed site for the Batu Retention Pond is situated on exhausted mining land belonging to the Government. Current urban development pressure, however, can be seen in the surrounding areas owing to strong housing demand in the Federal Territory.

Future development plans, prepared by the Planning and Building Control Department of Kuala Lumpur City Hall are taken into consideration in the site proposal. According to the development plans tabulated in Fig. D-11 the following issues are noted.

a) Lots of 'I1', 'IP1' and 'R2' are already assigned to a private developer for the purpose of residential and industrial development. The existing pond is being filled at present.

b) The Metropolitan Park which is proposed by City Hall on the basis of Kuala Lumpur Structure Plan, is designated as lot 'T1'. It is recommended that the proposed Metropolitan Park will be used as a flood retention pond and park. However, the area has inadequate water storage capacity.

c) Lots 'R1', 'R3' and 'R4' as well as 'T1' of Metropolitan Park are recommended for use as retention ponds and parks. In order to cut down the construction cost of the retention pond, it would be pragmatic to use the existing pond as much as possible.

Further consideration regarding the construction cost as well as technical and design aspects for the retention pond is given in the other parts of this Report.

5.3 Other Related Planning Issues

5.3.1 Squatter Relocation Program

According to the squatter census conducted by the Kuala Lumpur City Hall, the squatter area occupied about 1,500 ha or 6.1% of the total land area of Kuala Lumpur, and squatter population was 249,500 persons or 49,400 household in 1978.

Most of the squatter settlements are located in the lowland areas along the rivers and in ex-mining areas. In particular, the number of squatter settlements within 30 m range from river bank in Kuala Lumpur was estimated as follows.

- Klang River : 289 squatter buildings, 1390 households
- Gombak River : 258 squatter buildings, 1420 households
- Batu River : 315 squatter buildings, 1750 households
- Kerayong River : 441 squatter buildings, 2190 households

These lowland squatter areas suffer from flooding problems and are lacking in basic infrastructure.

In order to solve these squatter problems, a squatter relocation program has been carried out by the government on a periodic basis. As a result, the squatter population within Kuala Lumpur is estimated at only 149,000 persons in 1987. In 1988/1989, a total of approximately 1,600 squatter households scattered within Kuala Lumpur will be moved to

longhouses or flats erected under this program. With regard to the low-lying squatter areas along the river, some 530 squatter families are targetted for relocation. From the viewpoint of flood mitigation, the provision of a relocation program for squatters in the low-lying areas is one of the prerequisites for implementing the flood mitigation works.

5.3.2 Natural Retarding Basin

At about 6.5 km downstream of the Puchong Drop, there is a potential site for a natural retarding basin. During the severe flood of 1971, this area was inundated with the flood water of the Klang River.

With regard to the present land use of the proposed area for the natural retarding basin, most of the areas are occupied by natural forest, swamp and agriculture. These areas have a status of Malay Reservation or Forest Reserve as illustrated in Fig. D-12. There are some scattered houses in Bt Kemuning Malay Reservation, which is located in the lowland area along the Klang River, having building form with elevated floor to protect against flooding.

According to the future development plan, several trunk roads such as Shah Alam Highway, North-South Link and South Klang Valley Expressway will be developed in the north of the area. Some of the ex-mining lands and plantation estates, which is mainly located in the east of the Klang River, have been alloted for housing development.

Accordingly, the lowland area centering Kuala Langat (North) Forest Reserve areas will be protected from the surrounding urbanization and should be used for the natural retarding basin with about 17 km^2 land in order to reduce flood water in the downstream of the Klang River. Bt.Kemuning Malay Reservation area located along the Klang River may be also used as a natural retarding basin.

REFERENCE

1. FIFTH MALAYSIA PLAN 1986-1990, Mar. 1986, by Prime Minister's Department

2. KLANG VALLEY PERSPECTIVE PLAN, Sep. 1984, by Klang Valley Planning Secretariat

3. KUALA LUMPUR STRUCTURE PLAN, Aug. 1984, by Dewan Bandaraya Kuala Lumpur

4. KLANG DRAFT STRUCTURE PLAN, 1986-2005, by Selangor State Government, Klang Local Planning Authority

5. BANGI DRAFT STRUCTURE PLAN, 1986-2005, by Selangor State Government and Ulu Langat Local Planning Authority

6. SHAH ALAM EXTENTION PLAN 1983, by Selangor State Government

7. KLANG VALLEY TRANSPORT STUDY, FINAL REPORT, MAIN VOLUEM, Mar. 1987, by Government of Malaysia and Japan International Cooperation Agency

8. PROPERTY MARKET REPORT 1986, by Ministry of Finance, Malaysia

9. ECONOMIC REPORT, 1986/1987, by Ministry of Finance, Malaysia

10. YEAR BOOK OF STATISTIC 1986, by Department of Statistic

11. POPULATION AND HOUSING CENSUS OF MALAYSIA 1980, STATE POPULATION REPORT FOR SELANGOR, Oct. 1983, by Department of Statistic

12. POPULATION AND HOUSING CENSUS OF MALAYSIA 1980, STATE POPULATION REPORT FOR WILAYAH PERSEKUTUAN, Nov. 1983, by Department of Statistic Malaysia, Kuala Lumpur

13. POPULATION AND HOUSING CENSUS OF MALAYSIA 1980, POPULATION REPORT FOR LOCAL AUTHORITY AREA, Dec. 1986, by Department of Statistic

Table D-1 POPULATION TREND IN KLANG VALLEY REGION, 1957-1980

District	Population (1,000)			Average Annual Growth Rate (%)		Population Density in 1980 (Person/ha)
	1957	1970	1980	1957-70	1970- 80	
Federal Territory	-	678	977	-	3.7	40.09
Petaling District	-	198	382	-	6.8	7.84
Klang District	-	208	296	-	3.6	4.70
Gombak District	-	73	176	-	9.3	2.69
Hulu Langat District	-	110	188	-	5.5	2.27
Klang Valley Region	720	1,266	2,020	4.4	4.8	7.10
Selangor State and Federal Territory	1,013	1,629	2,493	3.7	4.3	2.97
Peninsular Malaysia	6,279	8,810	11,427	2.6	2.6	0.35

Source: Population Census 1970, 1980

: Klang Valley Perspective Plan, 1984

Table D-2 HOUSING SITUATION IN KLANG VALLEY REGION, 1980

Items	District					Klang Valley Total
	Federal Territory	Petaling	Klang	Gombak	Hulu Langat	
No. of Housing Units (1)	175,503	79,717	51,761	36,853	38,109	381,943
Housing Density per Km2	720	164	82	56	46	134
Percentage Share of housing Units in Klang Valley	46.0%	20.9%	13.6%	9.6%	10.0%	100%
Percentage Share of Population in Klang Valley	48.4%	18.9%	14.7%	8.7%	9.3%	100%
No. of Persons per Housing Unit	5.6	4.8	5.7	4.8	4.9	5.3
No. of Squatter Units	40,934	22,931	2,229	3,967	3,550	73,611
Percentage Share of Squatter in Total Housing Units	23.3%	28.8%	4.3%	10.8%	9.3%	19.3%
Percentage Share of Housing Units with Electricity Supply	80.6%	79.6%	85.6%	79.2%	78.2%	80.7%
Percentage Share of Housing Units with Water Supply	92.5%	90.1%	93.5%	87.1%	86.1%	91.1%

Source: KLANG VALLEY PERSPECTIVE PLAN, 1984

Note: (1) *Including Squatter*

Table D-3 GROSS REGIONAL PRODUCT IN SELANGOR AND KUALA LUMPUR, 1980 AND 1985 (IN 1978 PRICES)

Sector	1980 (M$ million)			1985 (M$ million)			Annual Growth Rate, 1980-1985 (%)		
	Malaysia	Selangor	Kuala Lumpur	Malaysia	Selangor	Kuala Lumpur	Malaysia	Selangor	Kuala Lumpur
Primary Sector	14,676	1,556	68	18,502	1,656	64	4.2	1.3	-1.2
Secondary sector	10,998	3,027	1,384	14,405	3,936	1,807	5.5	5.4	5.5
Manufacturing	8,932	2,570	1,102	11,357	3,310	1,421	4.9	5.2	5.2
Construction	2,066	457	282	3,048	626	386	8.1	6.5	6.5
Tertiary Sector	17,836	2,263	4,645	26,138	3,363	7,013	7.9	8.2	8.6
Commercial	5,383	509	2,038	7,551	748	2,992	7.0	8.0	8.0
Services	12,453	1,754	2,607	18,587	2,615	4,021	8.3	8.3	9.1
Total	43,510	6,846	6,097	58,595	8,955	8,884	6.1	5.5	7.8
GDP at purchasers' value	44,702	7,014	6,246	59,344	9,043	8,971	5.8	5.2	7.5
Population ('000)	13,879.2	1,521.6	981.0	15,791.1	1,822.1	1,152.6	2.6	3.7	3.3
Per capita GDP(M$)	3,221	4,610	6,367	3,758	4,963	7,783	3.1	1.5	4.1
Ratio to Malaysia average	1.00	1.43	1.98	1.00	1.32	2.07	-	-	-

Source: FIFTH MALAYSIA PLAN, 1986-1990

Table D-4 EMPLOYMENT BY DISTRICT IN KLANG VALLEY REGION, 1970-1980

District	Employment (1,000)		Share (%)		Annual Growth Rate (%)
	1970	1980	1970	1980	1970-80
Federal Territory	237.4	513.0	57.7	57.7	8.0
Petaling	79.6	195.8	19.3	22.0	9.4
Klang	53.8	105.9	13.1	11.9	7.0
Gombak	15.4	37.6	3.7	4.2	9.3
Hulu Langat	25.2	36.9	6.1	4.1	3.9
Total	411.4	889.2	100.0	100.0	8.0

Source: Klang Valley Perspective Plan, 1984

Table D-5 EMPLOYMENT BY SECTOR IN KLANG VALLEY REGION, 1970-1980

Sector	Employment (1,000)		Share in Klang Valley (%)		Annual Growth Rate (%)
	1970	1980	1970	1980	1970-80
Agriculture	44.9	40.8	10.9	4.6	-0.9
Mining	7.6	7.1	1.8	0.8	-0.7
Manufacturing	78.8	211.3	19.1	23.8	10.4
Construction	22.7	79.9	5.5	9.0	13.4
Utilities	5.2	14.2	1.3	1.6	10.6
Transportation	27.7	61.1	6.7	6.9	8.2
Goverment	76.0	142.2	18.5	16.0	6.5
Trade and Private Services	148.5	332.6	36.1	37.4	8.4
Total	411.4	889.2	100.0	100.0	8.0

Source: Klang Valley Perspective Plan, 1984

Table D-6 PRESENT LAND USE COMPOSITION IN THE KLANG RIVER BASIN, 1985

Landuse Category	Sub-Basin			Total Basin
	Upper Basin (1)	Middle Basin (2)	Lower Basin (3)	
Residential	11,350	12,380	4,160	27,890
Commercial	590	80	140	810
Industrial	260	610	970	1,840
Institutional	150	1,570	1,570	3,290
Recreational	460	750	390	1,600
Mining	420	1,140	2,650	4,210
Agriculture	10,410	7,310	36,190	53,910
Forest	22,180	1,540	11,570	35,290
Total	45,820	25,380	57,640	128,840

unit : ha

Source: Calculated by the Study Team

Note: The whole Klang River Basin is divided into the following three sub-catchment areas: (1) Upper Basin is the upper catchment area covering from the Sulaiman Bridge; (2) Middle Basin is the middle catchment covering from Puchong Drop to Sulaiman Bridge; and (3) Lower Basin is the lower catchment area from Puchong Drop. The above sub-catchment boundary is shown in Fig. D-1.

Table D-7 PRESENT LAND USE COMPOSITION IN THE FLOOD PRONE AREA, 1985

Landuse Category	No. of Mesh	Area	
		(ha)	(%)
Residential	153	3,810.0	(20.7)
Commercial	27	665.0	(3.6)
Industrial	27	675.0	(3.7)
Institutional	28	697.5	(3.8)
Recreation/Cemetery	9	220.0	(1.2)
Sub-Total of Urbanized Area	244	6,067.5	(33.0)
Agriculture	226	5,642.5	(30.7)
Mining	97	2,425.0	(13.2)
Forest Reserve/Swamp	173	4,260.0	(23.2)
Total	740	18,395.0	(100.0)

Source: Calculated by the Study Team

Table D-8 PRESENT LAND USE COMPOSITION IN THE FEDERAL TERRITORY OF KUALA LUMPUR

Landuse Categories		Existing Area	Committed Area	Total Area
Residential	(ha)	4,786	2,360	7,146
	(%)		(56.2)	(29.5)
Commercial	(ha)		284	892
	(%)	(3.0)	(6.8)	(3.7)
Industry	(ha)	580	106	686
	(%)	(2.9)	(2.5)	(2.8)
Institution/	(ha)	2,596	579	3,175
Education	(%)	(13.0)	(13.8)	(13.1)
Openspace/	(ha)	983	647	1,630
Cemetery	(%)	(4.9)	(15.4)	(6.7)
Other Use	(ha)	2,203	225	2,427
	(%)	(11.0)	(5.4)	(10.0)
Squatter	(ha)	1,512		1,512
	(%)	(7.5)		(6.2)
Sub-Total	(ha)	13,767	4,201	17,968
(Built Up Area)	(%)	(68.7)	(100.0)	(74.1)
Minig	(ha)	1,735		1,735
	(%)	(8.7)		(7.2)
Undeveloped/	(ha)	4,537		4,537
Agriculture	(%)	(22.6)		(18.7)
Total	(ha)	20,039	4,201	24,240
	(%)	(100.0)	(100.0)	(100.0)

Source: Kuala Lumpur Structure Plan, 1984
Note: Existing Area includs the area Under Construction

Table D-9 PRESENT LAND USE COMPOSITION IN MAJOR URBAN CENTERS FOR PETALING JAYA, SHAH ALAM AND KLANG

Landuse Categories		Petaling Jaya	Shah Alam	Klang
Residential	(ha)	2,507	2,600	1,878
	(%)	57.6	47.4	30.9
Commercial	(ha)	241	40	113
	(%)	5.5	0.7	1.9
Industrial	(ha)	646	780	607
	(%)	14.9	14.2	10.0
Institutional	(ha)	78	120	252
	(%)	1.8	2.2	4.1
Recreational	(ha)	411	100	88
	(%)	9.4	1.8	1.4
Cemetery	(ha)	17	70	44
	(%)	0.4	1.3	0.7
Squatter	(ha)	76	-	90
	(%)	1.7		1.5
Sub-Total Built-Up Area	(ha)	3,976	3,710	3,072
	(%)	91.4	67.7	50.5
Mining	(ha)	-	-	-
	(%)			
Agriculture	(ha)	200	1,660	2,363
	(%)	4.6	30.3	38.9
Others	(ha)	174	110	647
	(%)	4.0	2.0	10.6
Total	(ha)	4,350	5,480	6,082
	(%)	100.0	100.0	100.0

Source : Kuala Lumpur Master Plan For Sewage and Sewerage Disposal, 1985
: Klang Structure Plan, Report of Survey, 1985

Table D-10 HIERARCHY AND MAJOR FUNCTIONS OF SIX URBAN CENTERS IN KLANG VALLEY REGION

TOWNS	HIERARCHY	MAJOR FUNCTIONS
Kuala Lumpur	National Centre	National Administrative Centre, Commercial and Trading Centre.
Shah Alam	State Centre	State Administrative Centre, Commercial and Trading Centre, Industrial Centre.
Petaling Jaya	District Centre	District Administrative Centre, Industrial Centre.
Klang	District Centre	District Administrative Centre, Heavy Industrial Centre, Trandportation Centre.
Bangi	District Centre	District Centre, Institutional Centre, Light Industrial Centre.
Selayang	District Centre	District Administrative Centre, Light Industrial Centre.

Source : Klang Vally Perspective Plan, 1984

Table D-11 TARGET POPULATION PROJECTION IN THE STRUCTURE PLANS

Towns		Year				
		1985	1990	1995	2000	2005
Kuala Lumpur 1)	Population (1,000)	-	1,550	-	2,200	-
	Annual Growth Rates(%)		4.1		3.6	
Shah Alam 2)	Population (1,000)	131	255	327	372	631
	Annual Growth Rates(%)		14.2	5.1	2.6	(ultimate)
Klang 3)	Population (1,000)	-	410.7	483.1	568.3	668.5
	Annual Growth Rates(%)		3	3.3	3.3	3.3

Source: 1) Kuala Lumpur Structure Plan, 1984.
2) Shah Alam Extension Plan, 1983.
3) Klang Draft Structure Plan, 1986.

Table D-12 TARGET POPULATION BY MAJOR URBAN CENTER IN KLANG VALLEY REGION, 1980-2000

Urban Center	Population			Annual Growth Rate (%)	
	1980	1990	2000	1980-1990	1990-2000
Kuala Lumpur	977,102	1,489,550	2,150,000	4.3	3.7
Petaling Jaya	220,065	280,000	400,000	2.4	3.6
Shah Alam	20,164	260,000	370,000	29.1	3.6
Klang	203,413	300,000	430,000	4.0	3.7
Bangi	33,339	125,000	180,400	14.1	3.7
Selayang	3,548	60,000	130,000	32.7	8.0
Other Town	196,938	267,533	428,900	3.1	4.8
Rural Area	365,230	500,943	670,700	3.2	3.0
Total Klang Valley	2,019,799	3,283,026	4,760,000	5.0	3.8

Source: Klang Valley Perspective Plan, 1984

Table D-13 POPULATION PROJECTION BY DISTRICT IN KLANG VALLEY REGION, 1985-2005

District		Year				Increased Population 1985-2005
		1980	1985	1995	2005	
Kuala Lumpur	Number (1,000)	997	1,215	1,770	2,240	1,025
	Annual Growth Rate(%)	-	4.0	3.8	2.4	
Gombak District	Number (1,000)	176	243	444	746	503
	Annual Growth Rate(%)	-	4.7	6.2	5.3	
Hulu Langat District	Number (1,000)	188	240	386	630	390
	Annual Growth Rate(%)	-	5.0	4.9	5.0	
Petaling District	Number (1,000)	382	491	850	1,157	606
	Annual Growth Rate(%)	-	5.0	5.6	3.1	
Klang District	Number (1,000)	276	345	490	677	332
	Annual Growth Rate(%)	-	3.1	3.6	3.3	
Klang Valley	Number (1,000)	2,020	2,534	3,940	5,450	2,916
	Annual Growth Rate(%)	-	4.6	4.5	3.3	

Source: National Census, 1980
: Klang Valley Transportation Study, 1987

Table D-14 ESTIMATED GROSS REGIONAL PRODUCT (GRP)
FOR KLANG VALLEY REGION, 1985-2005

(M $ Million in 1978 Constant Price)

Year	Malaysia	Kuala Lumpur	Selangor State	Kuala Lumpur and Selangor State	Klang Valley Region	Percentage Share in GDP of Malaysia
1985	59,344	8,971	9,043	18,014	15,511	26.1%
1990	75,599	12,068	11,328	23,396	20,564	27.2%
1995	96,665	16,143	15,273	31,416	28,275	29.3%
2005	157,457	27,555	25,823	53,378	48,842	31.0%

Source: Fifth Malaysia Plan 1986-1990

: Klang Valley Transportation Study, 1987

Table D-15 FUTURE LAND USE COMPOSITION IN THE KLANG RIVER BASIN, 2005

Landuse Category	Sub-Basin			Total Basin
	Upper Basin	Middle Basin	Lower Basin	
Residential	14,890	15,410	10,950	41,250
Commercial	1,120	640	380	2,140
Industrial	690	1,320	1,830	3,840
Institutional	680	1,240	1,910	3,830
Recreational	950	1,750	2,750	5,450
Mining	170	450	2,380	3,000
Agriculture	4,410	2,490	18,990	25,890
Forest	22,910	2,080	18,450	43,440
Total	45,820	25,380	57,640	128,840

(Unit : ha)

Source : Calculated by the Study Team.

Table D-16 PRESENT CONDITION OF MINING AREA IN KLANG VALLEY REGION, 1986

Mining Category	District				Total Klang Valley
	Petaling District	Gombak District	Hulu Langat District	Kuala Lumpur	
Active Mining Area	1,043.0	182.3	145.7	0.0	1,371.0
Work Out Ex-Mining Area	1,080.0	1,888.2	1,853.7	2,040.0	6,861.9
Sub-Total of Active and Ex-Mining Area	(2,123.0)	(2,070.2)	(1,999.4)	(2,040.0)	(8,232.9)
Development Area on Ex-Mining Land	1,205.5	95.0	159.7	3,050.0	4,510.2
Total	3,328.5	2,165.5	2,159.1	5,090.0	12,743.1

(Unit : ha)

Source : District Offices

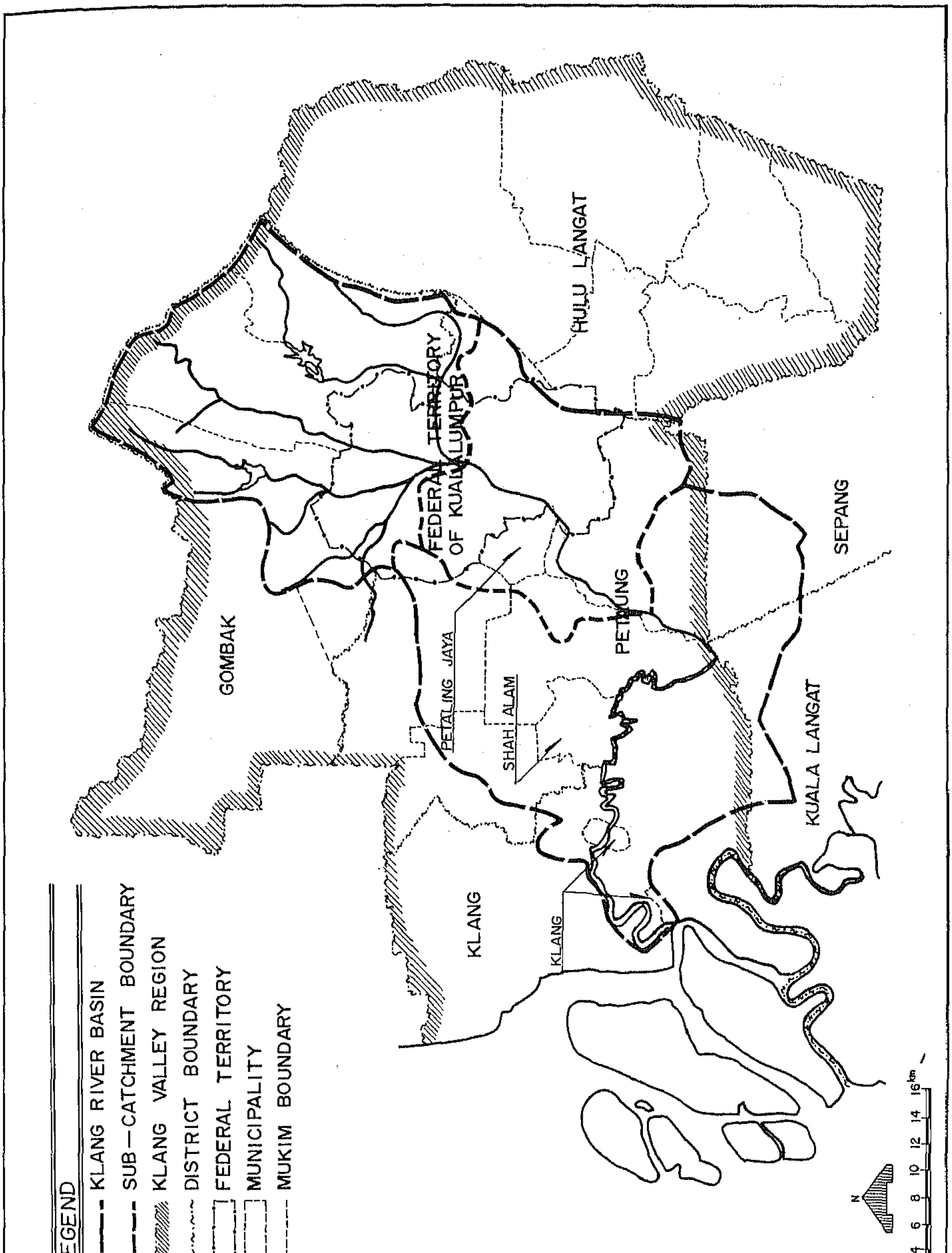

FIG. D-1 **ADMINISTRATIVE STRUCTURE FOR THE STUDY AREA**

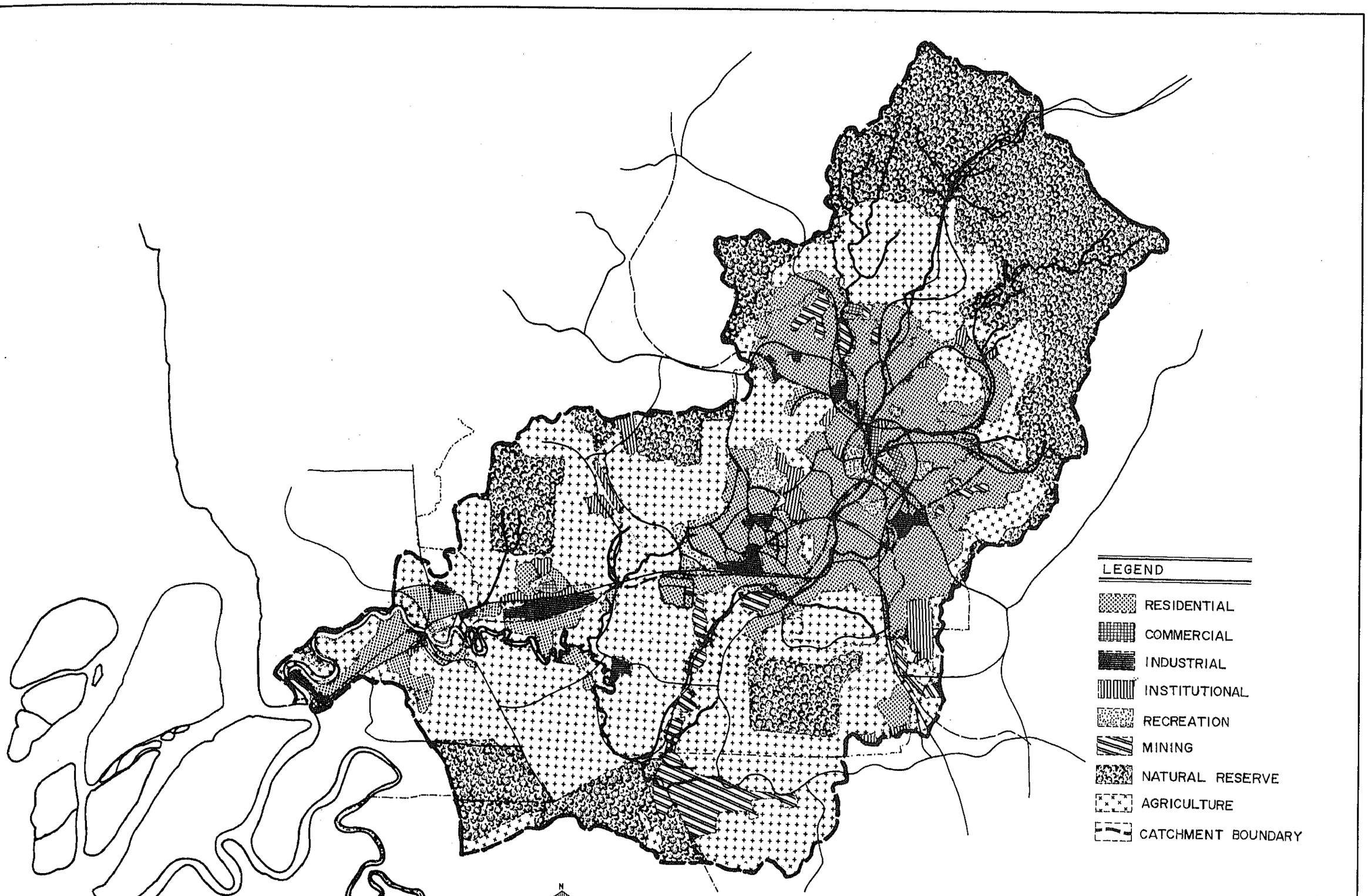

FIG. D-2	PRESENT LAND USE IN THE KLANG RIVER BASIN, 1985
THE STUDY ON THE FLOOD MITIGATION OF THE KLANG RIVER BASIN	

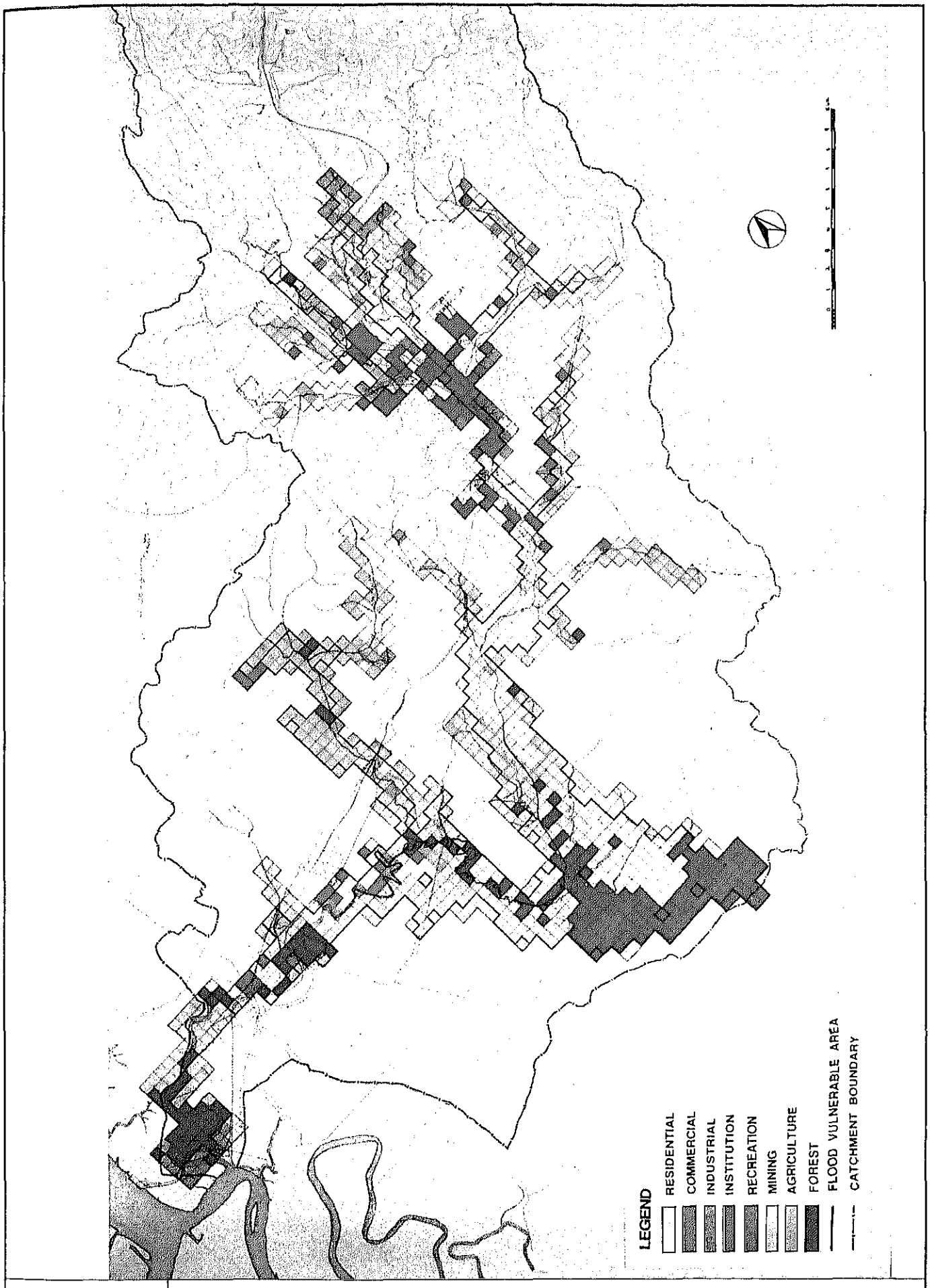

FIG. D-3 **PRESENT LAND USE PATTERN IN THE FLOOD PRONE AREA, 1985**

THE STUDY ON THE FLOOD MITIGATION OF THE KLANG RIVER BASIN

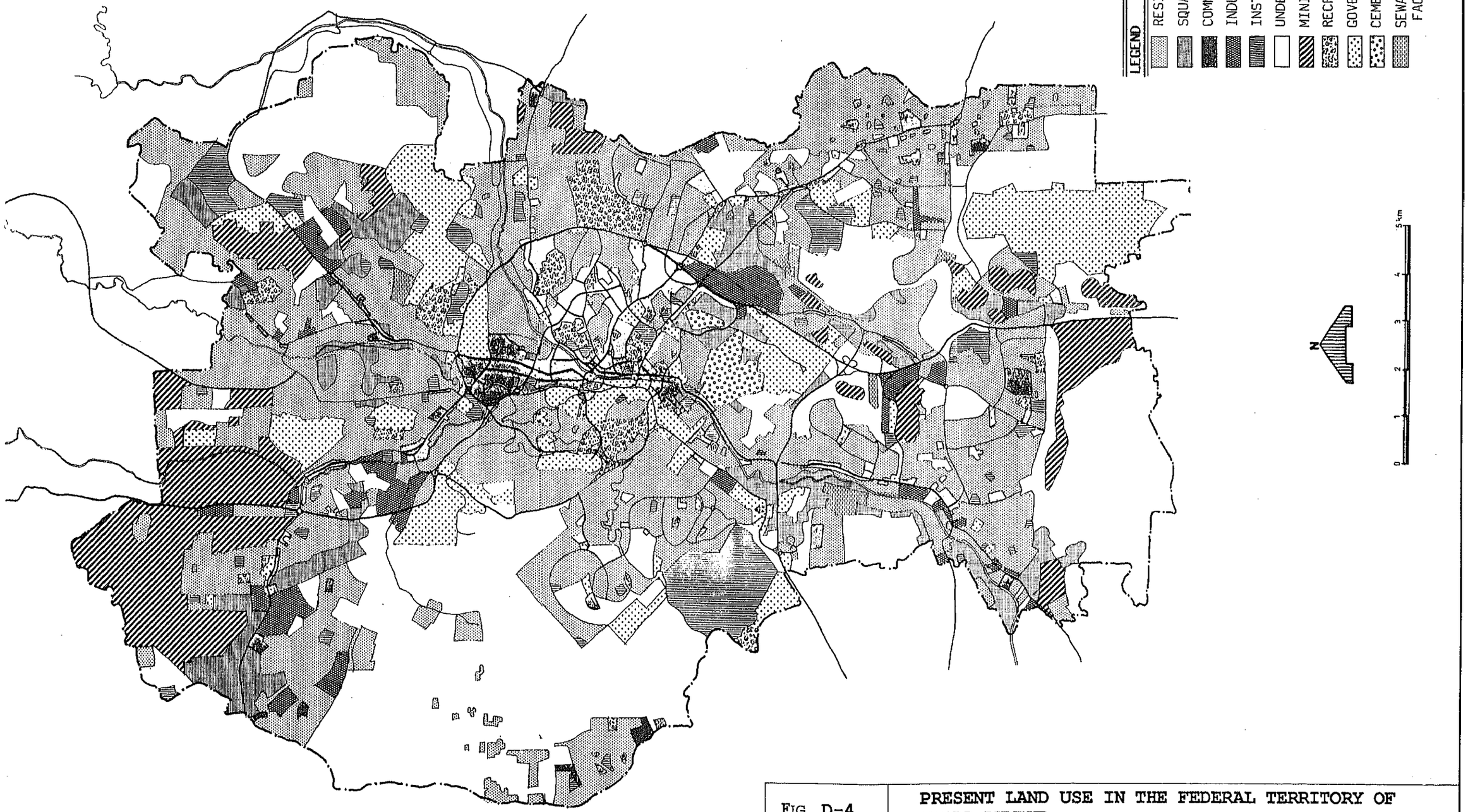

FIG. D-4	PRESENT LAND USE IN THE FEDERAL TERRITORY OF KUALA LUMPUR

THE STUDY ON THE FLOOD MITIGATION OF THE KLANG RIVER BASIN

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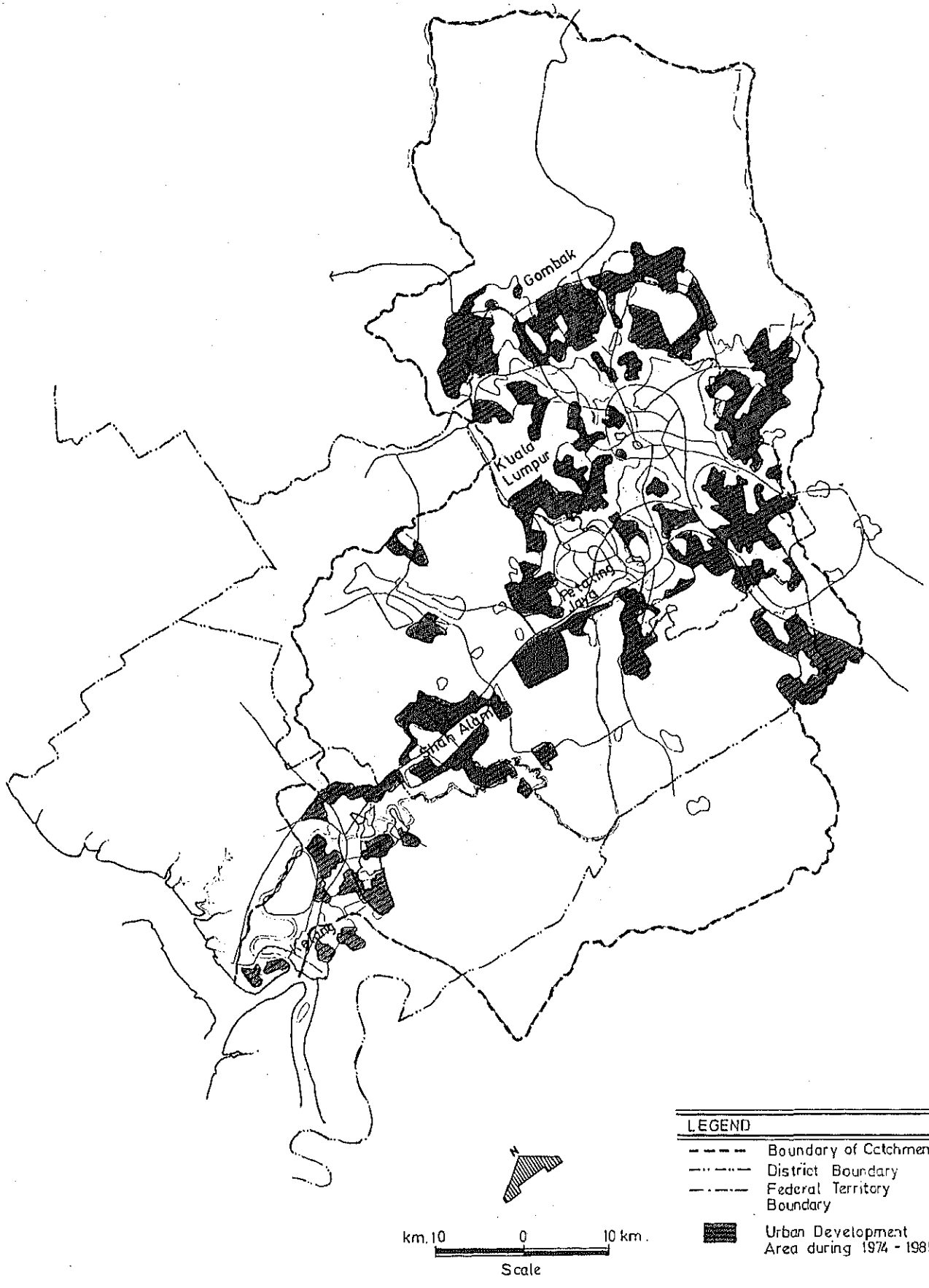

FIG. D-5 **PAST DEVELOPMENT TREND IN THE KLANG RIVER BASIN, 1974-1985**

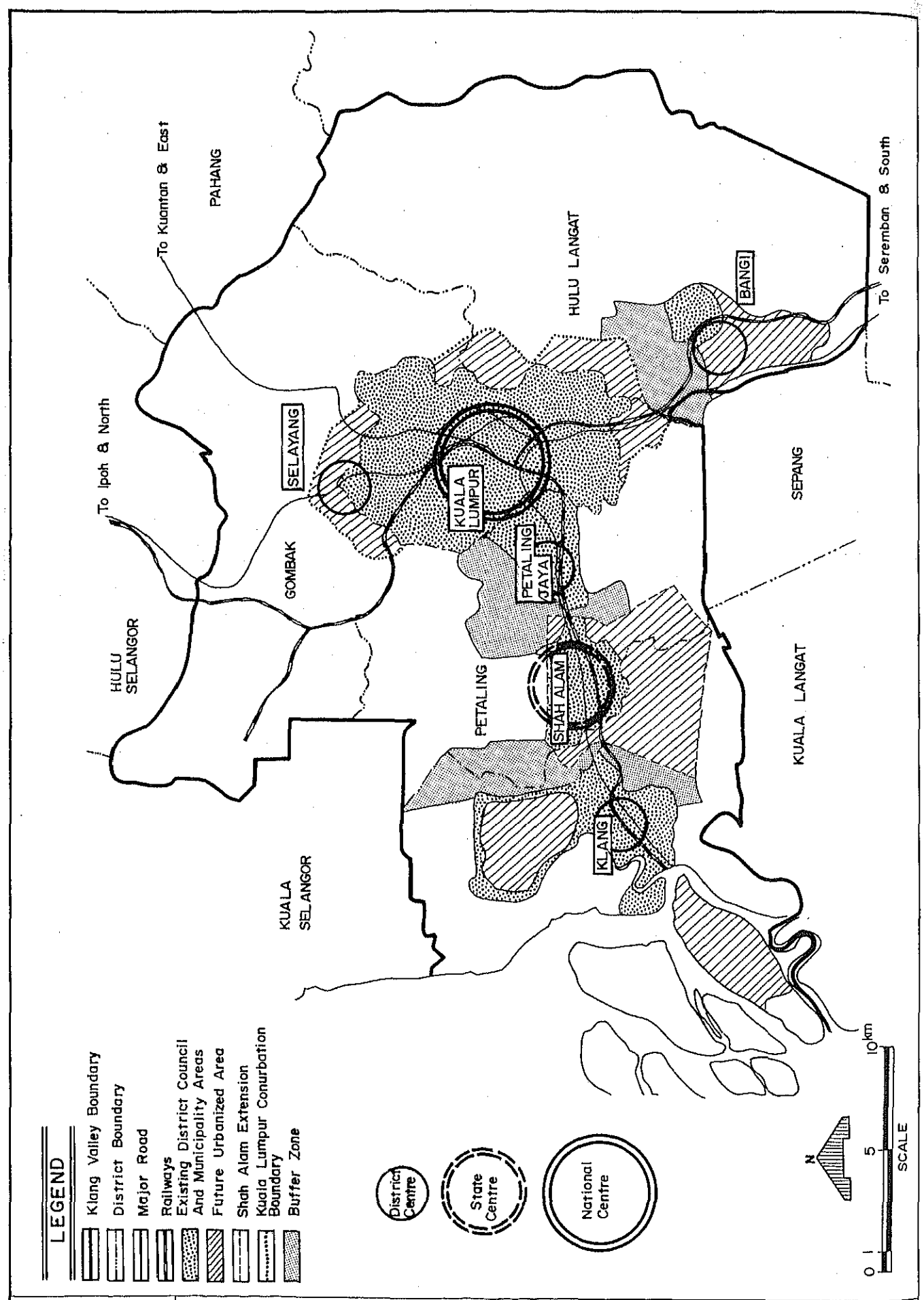

FIG. D-6 DISTRIBUTION OF URBAN CENTER IN KLANG VALLEY REGION, 2000

THE STUDY ON THE FLOOD MITIGATION OF THE KLANG RIVER BASIN

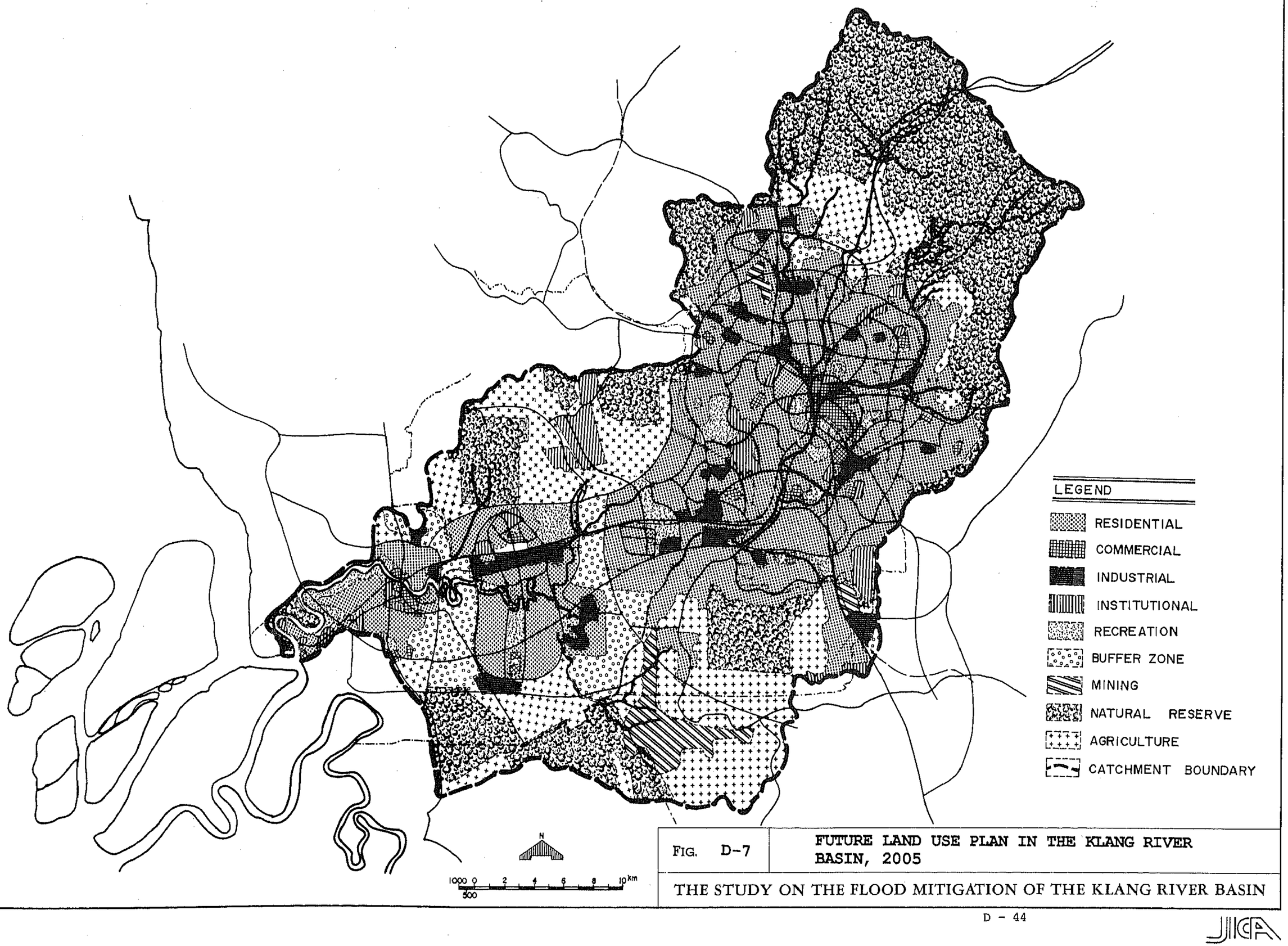

FIG. D-7 FUTURE LAND USE PLAN IN THE KLANG RIVER BASIN, 2005

THE STUDY ON THE FLOOD MITIGATION OF THE KLANG RIVER BASIN

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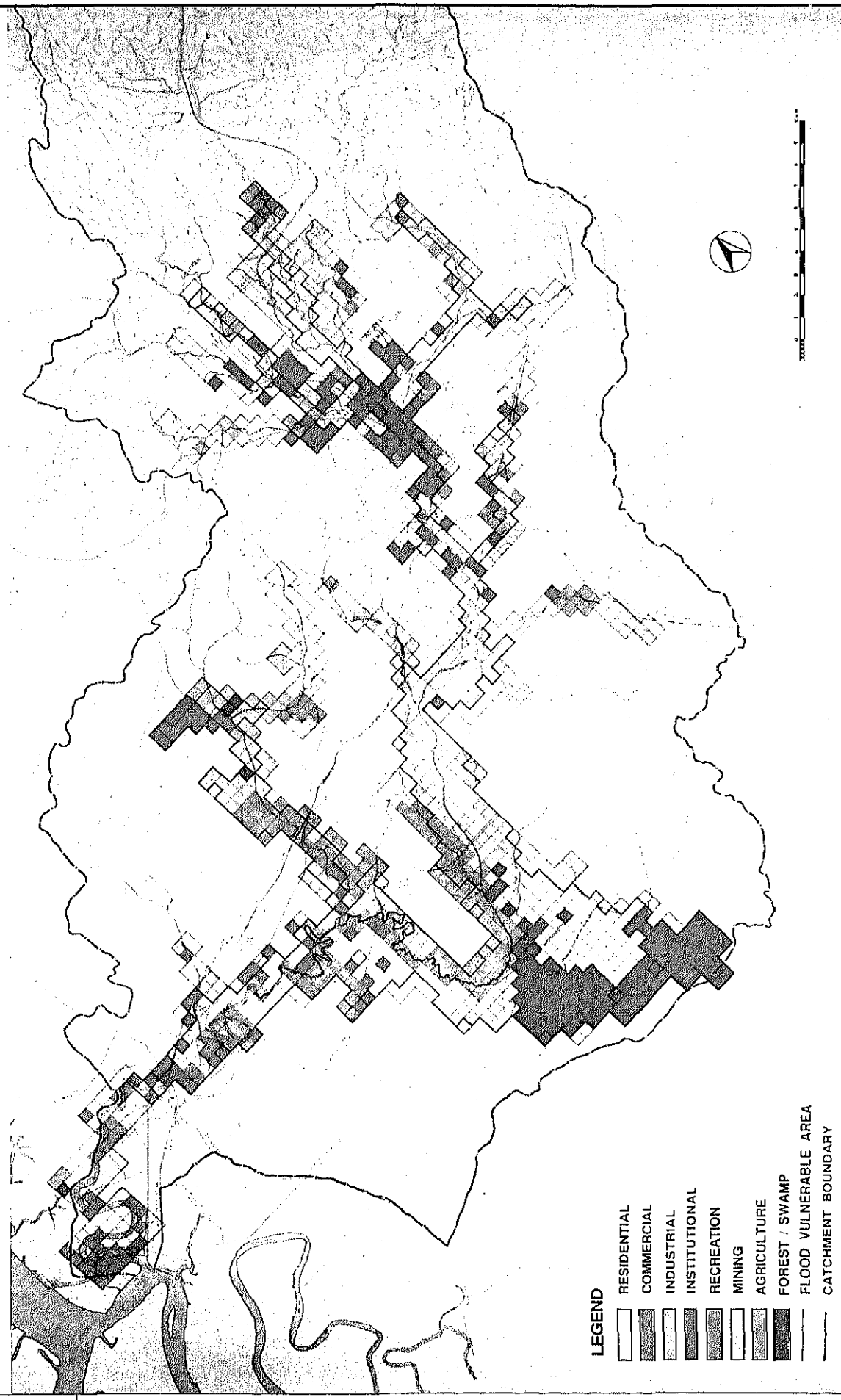

FIG. D-8 **FUTURE LAND USE PATTERN IN THE FLOOD PRONE AREA, 2005**

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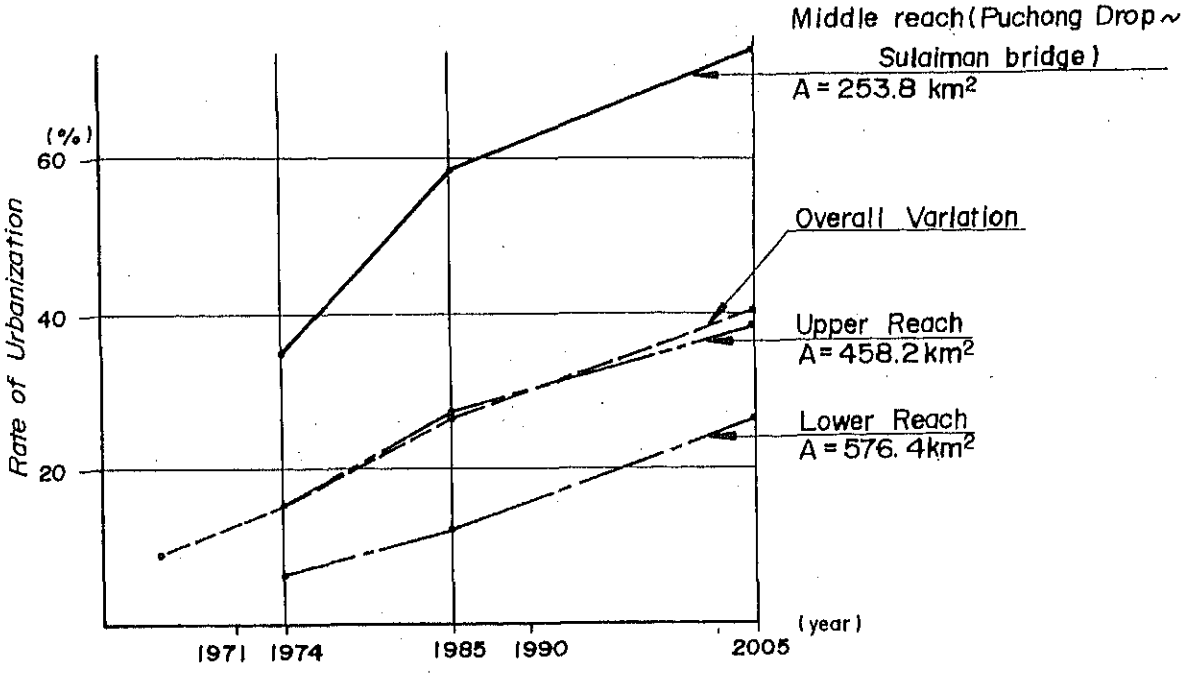
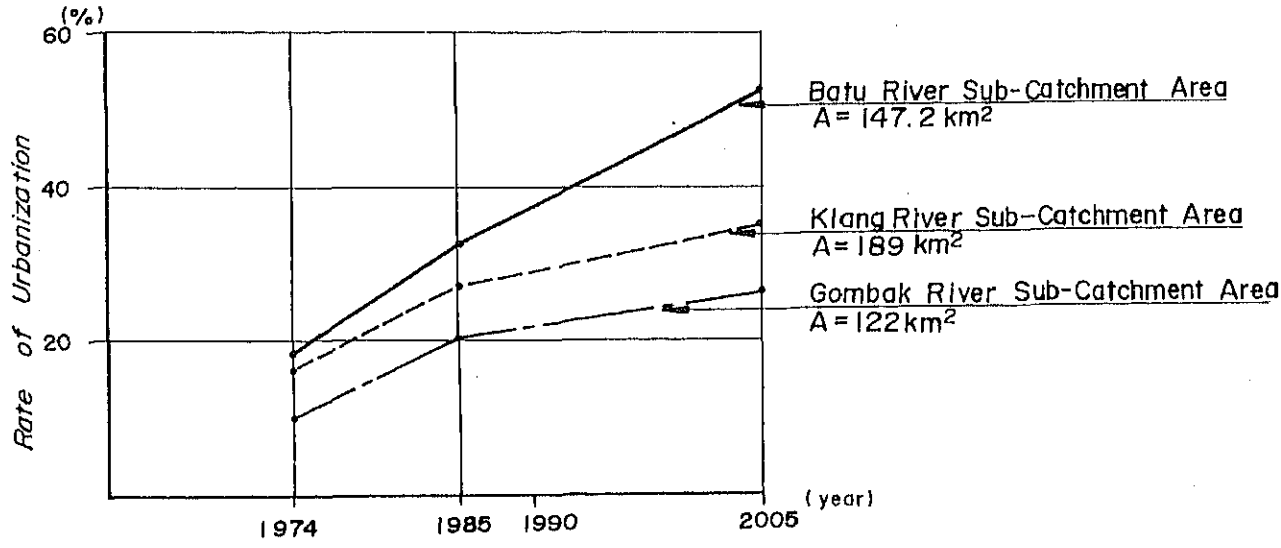


Urbanization Rate by Upper, Middle and Lower Reaches of the Klang River Basin



Urbanization Rate by 3 Sub-Catchment Areas in the Upper Reach

FIG. D-9	FUTURE URBANIZATION TREND

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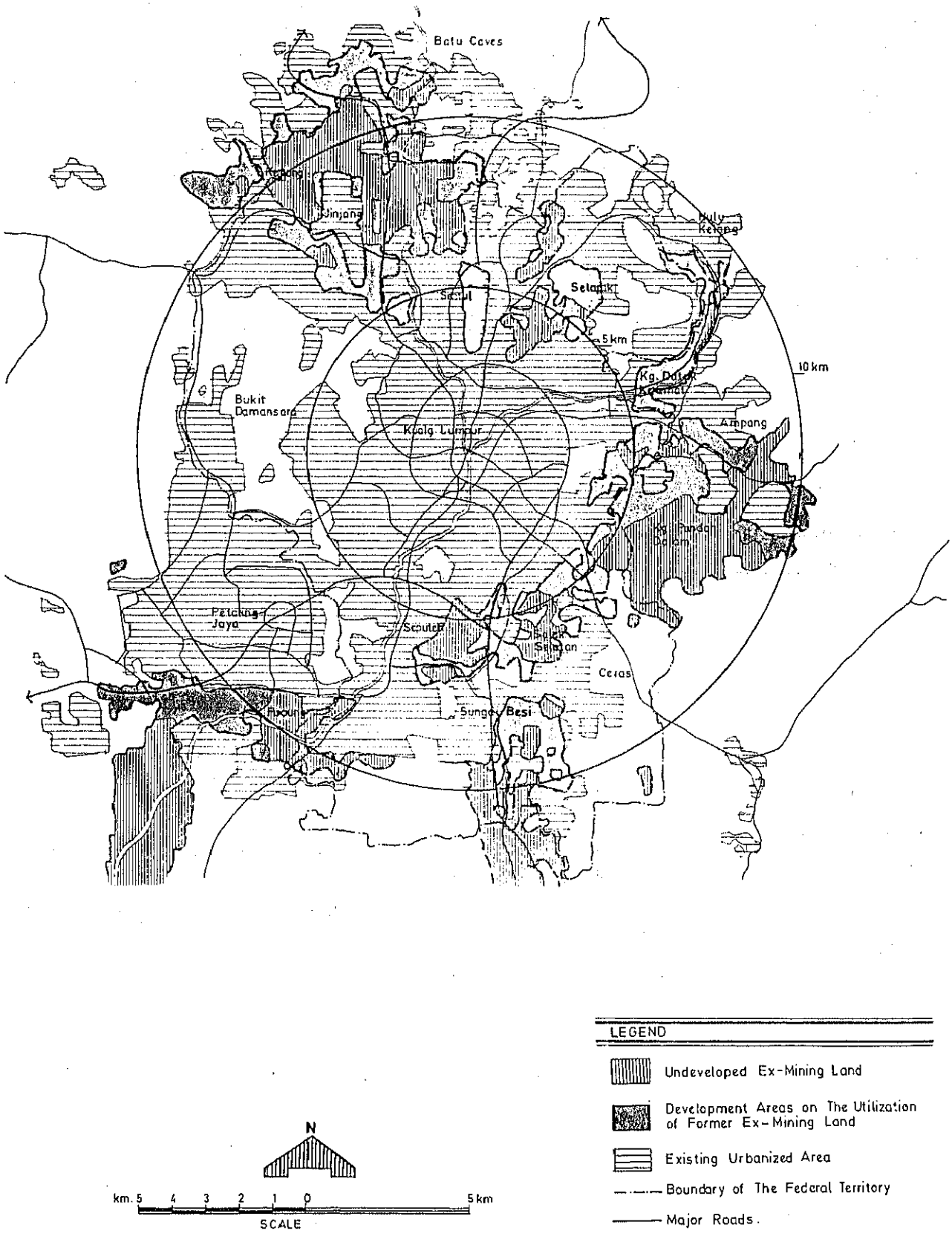

FIG. D-10 **PAST DEVELOPMENT TREND OF THE EX-MINING LAND**

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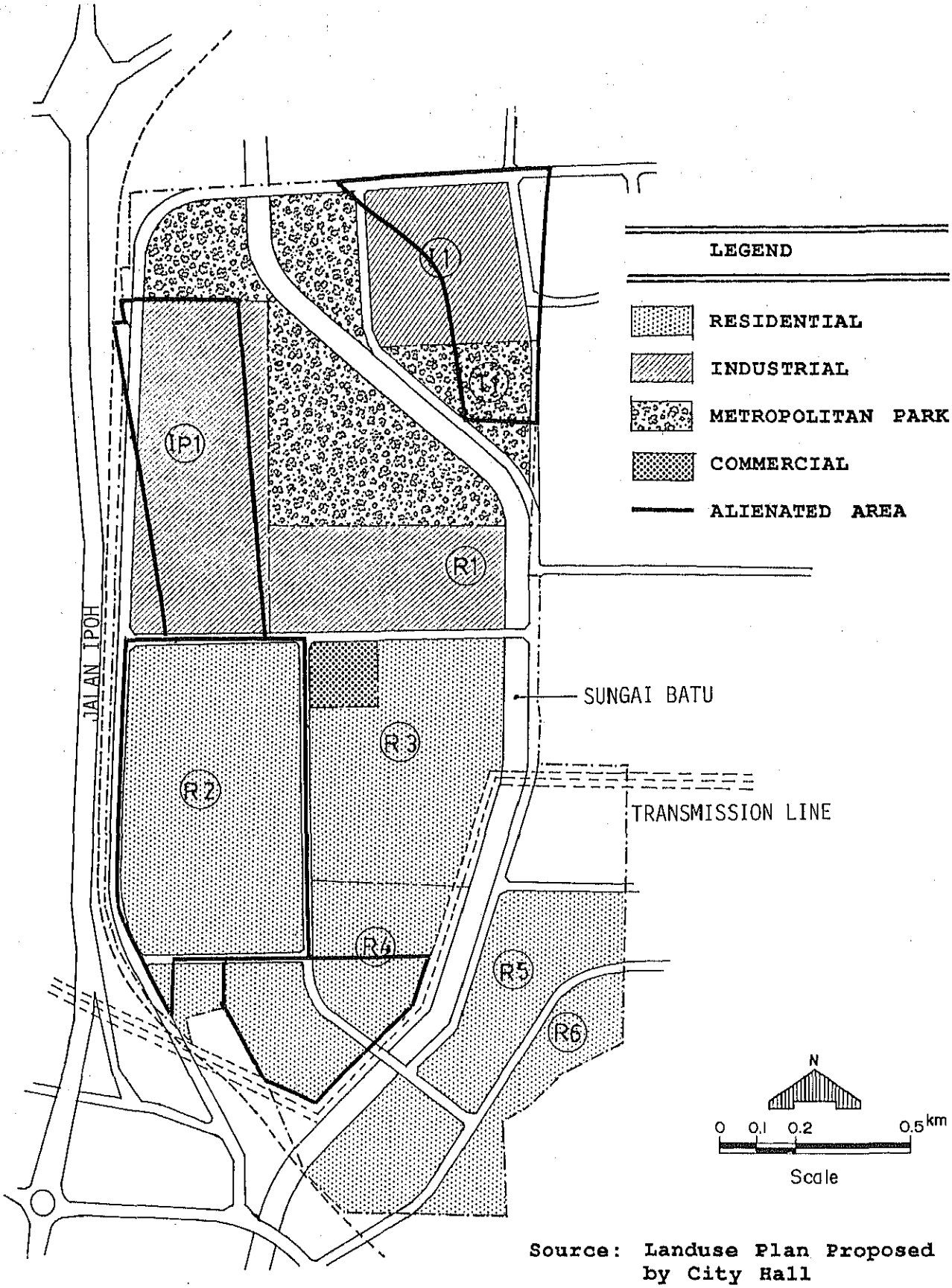

Source: Landuse Plan Proposed by City Hall

FIG. D-11 FUTURE LAND USE PLAN SURROUNDING THE PROPOSED BATU RETENTION POND

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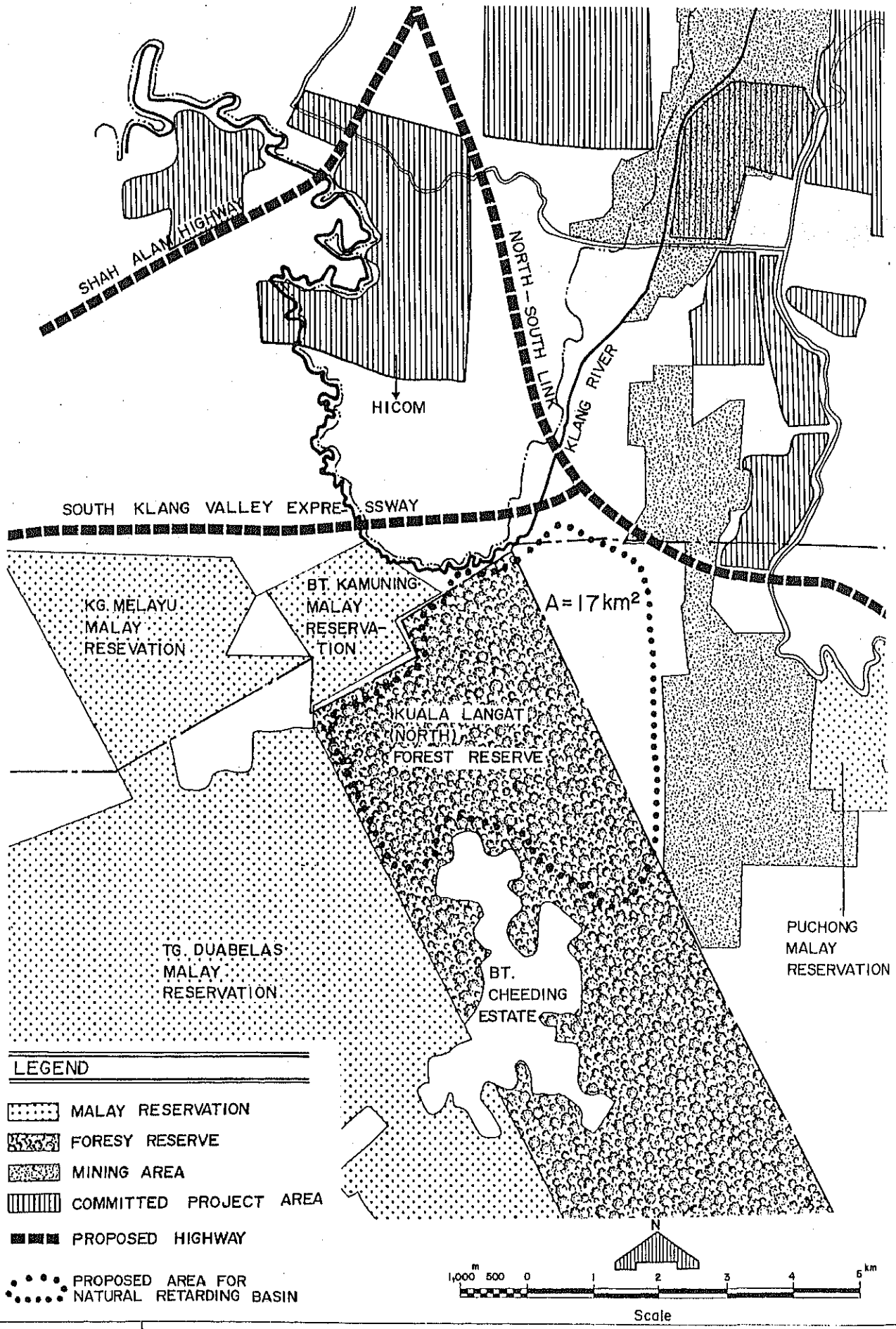

FIG. D-12 **PRESENT CONDITION FOR THE PROPOSED NATURAL RETARDING BASIN**

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