

PART 1

DRAINAGE STRUCTURE PLAN

**THE STUDY ON INTEGRATED URBAN DRAINAGE IMPROVEMENT
FOR MELAKA AND SUNGAI PETANI
IN MALAYSIA**

FINAL REPORT

VOL. 2 MAIN REPORT

PART 1: DRAINAGE STRUCTURE PLAN

TABLE OF CONTENTS

GENERAL MAP

CHAPTER 1.	INTRODUCTION	
1.1	Background of the Study	1-1
1.2	Objectives of the Study.....	1-1
1.3	Study Area	1-2
1.4	Contents of the Report.....	1-3
CHAPTER 2.	PRESENT CONDITION OF THE STUDY AREA	
2.1	Socio-Economic Conditions	2-1
2.2	Topography	2-2
	2.2.1 Sungai Petani	2-2
	2.2.2 Melaka.....	2-2
2.3	Present Land Use	2-3
	2.3.1 Present Land Use in Sungai Petani	2-3
	2.3.2 Present Land Use in Melaka	2-5
2.4	Drainage Conditions	2-7
	2.4.1 Drainage Channel.....	2-7
	2.4.2 Flood Detention Ponds.....	2-8
2.5	River Channel Conditions.....	2-9
2.6	Flood Damage Conditions	2-11
2.7	Surface Soil Conditions and Ground Infiltration Capacity ..	2-11
2.8	Environmental Conditions	2-12
CHAPTER 3.	HYDRAULIC AND HYDROLOGICAL ANALYSES	
3.1	Rainfall Analysis	3-1
	3.1.1 Rainfall Gauging Data	3-1
	3.1.2 Rainfall Intensity-Duration Curves.....	3-1
	3.1.3 Model Hyetograph	3-3
3.2	Runoff Analysis	3-4
	3.2.1 Basin Runoff Model.....	3-4
	3.2.2 Channel Flow Model.....	3-6

	3.2.3	Results of Simulation.....	3-7
	3.3	Analysis of Hydrological Effect of Basin Flood Detention Facility	3-8
	3.3.1	Types of Basin Flood Detention Facility.....	3-8
	3.3.2	Estimation of Standard Hydraulic Dimensions of Basin Flood Detention Facility.....	3-8
	3.3.3	Flood Runoff Simulation of Effects of Basin Flood Detention Facility	3-10
	3.4	Hydraulic Channel Flow Analysis.....	3-11
	3.5	Sediment Runoff.....	3-13
CHAPTER	4.	FORMULATION OF DRAINAGE IMPROVEMENT PLAN	
	4.1	Planning Framework.....	4-1
	4.1.1	Target Year and Future Land Use.....	4-1
	4.1.2	Design Level for Drainage Improvement.....	4-3
	4.1.3	Classification of Drainage and River Channels.....	4-5
	4.2	Structural Measures for Drainage Improvement	4-6
	4.2.1	Applicable Measures.....	4-6
	4.2.2	Alternative Plans.....	4-9
	4.2.3	Optimum Plan	4-10
	4.3	Non-structural Measures.....	4-13
	4.3.1	Establishment of Organizational Framework and Functional Responsibility	4-13
	4.3.2	Funding and Cost Recovery Measures.....	4-16
	4.3.3	Enforcement Capacity.....	4-18
	4.4	Preliminary Study on Prevention of River Overflow	4-20
	4.4.1	General.....	4-20
	4.4.2	Standard Design Flood Discharge and Possible Measures for Prevention of River Overflow	4-21
	4.5	Preliminary Design of Proposed Drainage Facilities.....	4-22
	4.5.1	Drainage Channel.....	4-22
	4.5.2	Flood Detention Pond	4-24
	4.5.3	Storage in Public Open Space.....	4-26
	4.5.4	Storage Tank in House Lot	4-27
	4.6	Operation and Maintenance Plan for Proposed Facilities	4-28
	4.6.1	Flood Detention Facilities.....	4-28
	4.6.2	Drainage Channel.....	4-29
CHAPTER	5.	PROJECT EVALUATION	
	5.1	Project Cost Estimation	5-1
	5.1.1	Estimation Bases.....	5-1
	5.1.2	Construction Work Volume.....	5-1

5.1.3	Project Cost.....	5-2
5.2	Financial Affordability	5-3
5.2.1	Budget Allocated to Urban Drainage Improvement	5-3
5.2.2	Budgetary Affordability for Urban Drainage Works	5-5
5.3	Environmental Evaluation	5-7
5.3.1	Environmental Issues	5-7
5.3.2	Proposed Environmental Improvement Measures	5-9

LIST OF TABLES

Table 2-1	Present Land Use.....	T-1
Table 2-2	Present Drainage Conditions in Sg. Petani.....	T-3
Table 2-3	Present Drainage Conditions in Melaka.....	T-6
Table 2-4	Existing Detention Pond in the Study Area.....	T-9
Table 2-5	Average Flow Capacity and Probable Discharge.....	T-10
Table 2-6	Flooding Conditions in Habitual Inundation Area.....	T-12
Table 3-1	Probable Point Rainfall Intensities.....	T-13
Table 3-2	Parameters for Land Use Categories Applied to Flood Simulation Model.....	T-14
Table 3-3	Features of River Channels Applied to Flood Runoff Simulation.....	T-15
Table 3-4	Present and Future Basin Run-off Discharge.....	T-17
Table 3-5	Present and Future Channel Flow Discharge.....	T-19
Table 3-6	Structure Features of Flood Regulation Facilities.....	T-21
Table 3-7	Tidal Level at Tanjung Dawai.....	T-22
Table 4-1	Flood Control Effects of Existing Detention Pond.....	T-23
Table 4-2	Proposed Agencies Related to Drainage Policy and Program.....	T-24
Table 4-3	Functional Responsibility for Drainage Facility.....	T-25
Table 4-4	Proposed Sources of Funding and Cost Recovery Measures.....	T-26
Table 4-5	Enabling Law and Enforcement Agency for Irrigal Activities on Urban Drainage.....	T-27
Table 4-6	Maintenance Items of Flood Detention Facilities.....	T-28
Table 5-1	Basic Unit Costs/Prices Applied for Cost Estimate in Sungai Petani and Melaka.....	T-29

LIST OF FIGURES

Fig. 2-1	Present Land Use Map.....	F-1
Fig. 2-2	Histogram on Extent of Drainage Basin.....	F-3
Fig. 2-3	Area and Storage Capacity of Existing Detention Pond.....	F-4
Fig. 2-4	Channel Flow Capacity and Probable Channel Flow Discharge (Sg. Malim; Mainstream and Sg. Ayer Salak).....	F-5
Fig. 2-5	Existing Major River Structures on Sg. Melaka.....	F-6
Fig. 2-6	Channel Flow Capacity and Probable Channel Flow Discharge (Sg. Malaka; Upstream from Diversion Weir and Sg. Cheng).....	F-7
Fig. 2-7	Habitual Inundation Area.....	F-8
Fig. 2-8	Soil Map of Study Area.....	F-13
Fig. 2-9	Legend of Soil Map.....	F-14
Fig. 3-1	Histogram of Observed Rainfall Duration.....	F-15
Fig. 3-2	Rainfall Intensity – Duration Curve.....	F-16

Fig. 3-3	Histogram of Peak Rainfall Occurrence in a Sequential Rainfall	F-17
Fig. 3-4	Model Hyetograph.....	F-18
Fig. 3-5	Division of Study Area in to Major River Basins	F-20
Fig. 3-6	Division of Major River Basin into Sub-basins	F-22
Fig. 3-7	Increment of Probable Discharge at the Down-most Point of River Channel from Present to Future (Year 2020).....	F-30
Fig. 3-8	Application of Basin Flood Detention Facility to Runoff Simulation Model.....	F-31
Fig. 4.1	Proposed Land Use.....	F-32
Fig. 4-2	Occupancy Rate of Built-up Area in Present and Future Land Use	F-34
Fig. 4-3	Comparison of Flood Control Effects among Alternatives in 5-year Flood	F-35
Fig. 4-4	Comparison of Flood Control Effects among Alternatives in 100-year Flood	F-36
Fig. 4-5	Flood Control Effects of Alternatives	F-37
Fig. 4-6	Proposed Institutional Organization Setup for Integrated Urban Drainage Improvement	F-38
Fig. 4-7	Standard Design Flood and Present River Flow Capacity	F-39
Fig. 4-8	Possible Site for Flood Retarding Basin	F-43
Fig. 4-9	Outline of Storm Outfall Structure.....	F-44
Fig. 4-10	Typical In / Outlet Structures for Detention Pond	F-45
Fig. 4-11	General Layout of Dry Pond	F-46
Fig. 4-12	General Layout of Wet Pond with Amenity Space	F-48
Fig. 4-13	Typical Plan of Storage System in Public Open Space.....	F-49
Fig. 4-14	Typical Collection System of Rainwater in Private House.....	F-50

ABBREVIATIONS AND GLOSSARY

GOVERNMENT OFFICES

AIFM	:	Asian Institute of Forest Management
DBKL	:	Kuala Lumpur City Hall Council
DGSM	:	Department of Geological Survey, Malaysia
DID	:	Department of Irrigation and Drainage
DOA	:	Department of Agriculture
DOE	:	Department of Environment
DOF	:	Department of Fisheries
DOLM	:	Department of Lands and Mines
DOS	:	Department of Statistics
DSMM	:	Department of Survey and Mapping, Malaysia
DSMP	:	Department of Survey and Mapping, Perak
DWNP	:	Department of Wildlife and National Parks
EPU	:	Economic Planning Unit
EXCO	:	State Executive Council
FAMA	:	Federal Agricultural and Marketing Authority
FD	:	Forest Department
FDPM	:	Forest Department of Peninsular Malaysia
JICA	:	Japan International Cooperation Agency
LGD	:	Local Government Department
LKIM	:	Fisheries Development Authority of Malaysia
LPP	:	Farmers Organization Authority
MD	:	Marine Department
MHLG	:	Ministry of Housing and Local Government
MMS	:	Malaysia Meteorological Service
MOA	:	Ministry of Agriculture
MPMBB	:	Melaka Historical City Municipal Council
MPSP	:	Sungai Petani Municipal Council
NCLG	:	National Council for Local Government
PWD	:	Public Works Department
SEDC	:	State Economic Development Corporation
SEPC	:	State Economic Planning Committee
SEPU	:	State Economic Planning Unit
SPC	:	State Planning Committee
TCPD	:	Town and Country Planning Department, Peninsular Malaysia

UNITS OF MEASUREMENT

<i>(Area)</i>		<i>(Other Measurements)</i>			
Ha, ha	:	hectare	Cu., cu.	:	cubic
m ²	:	square meter	cusec	:	cubic feet per second
km ²	:	square kilometer	m ³ /s	:	cubic meter per second
			dia.	:	diameter
			DPI	:	dot per inch
<i>(Weight)</i>			GB	:	gigabyte
Kg, kg	:	kilogram	Kbps	:	kilo bit per second
ton	:	1,000 kg	KB	:	kilo byte
			Km, km	:	kilometer
<i>(Volume)</i>			Mbps	:	megabit per second
GRT	:	Gross Relative Tonnage	sec, s	:	second
L, l, ltr	:	liter			

m³ : cubic meter Sq., sq. square
MCM : million cubic meters

(Electric)

MHz : megahertz H, Hz : hertz
VA : volt ampere kW : kilowatt
W : watt V : volt, voltage

MALAYSIAN TERMS

Jl. : jalan (road)
Kg. : kampong (village)
P., Pulau : island
Mk. : mukim
Sg. : sungai (river)

CURRENCY

RM : Malaysian Ringgit
US\$: United States Dollar
¥ : Japanese Yen

OTHERS

AAGR : Average Annual Growth Rate
EIA : Environment Impact Assessment
EIRR : Economic Internal Rate of Return
ESCP : Erosion and Sediment Control Plan
GDP : Gross Domestic Product
GIS : Geographic Information System
GNP : Gross National Product
GRDP : Gross Regional Domestic Products
IWK : Indah Water Konsortium Sdn Bhd
LGA : Local Government Act
LSD : Land and Survey Datum
MIEL : Malaysian Industrial Estate Limited
MP : Malaysia Plan
NLC : National Land Code
RSO : Rectified Skewed Orthomorphic
SDBA : Street Drainage and Building Act
SMIs : Small and Medium Scale Industries
URBL : Uniform Building By-laws
VJR : Virgin Jungle Reserve

CHAPTER 1. INTRODUCTION

1.1 Background of the Study

The rivers in Malaysia generally have steep slopes in the upper reaches to very gentle ones in the lower reaches where they usually meander and floods often occur. The urban areas in the lower reaches in particular suffer from serious damage by frequent flush floods associated with local torrential downpours.

Vital efforts have been made by the Department of Irrigation and Drainage (DID) as well as the other related government agencies by implementing various plans and countermeasures for urban drainage with the nationwide flood in 1972 as turning point. Most of the countermeasures so far adopted are however oriented to the conventional improvement of drainage channels that could hardly provide effective urban drainage because of the rapid progress of urbanization. Therefore, the formulation and implementation of an integrated urban drainage plan that may include basin runoff control by flood storage facilities is urgently required.

Under the above circumstances, the Government of Malaysia had requested the Government of Japan to extend technical cooperation for the study on urban drainage improvement. In response, the Government of Japan had decided to conduct a study, namely, “The Study on Integrated Urban Drainage Improvement for Melaka and Sungai Petani in Malaysia” (hereinafter referred to as “the Study”). The Study was entrusted to the Japan International Cooperation Agency (JICA), the institution responsible for the implementation of technical cooperation programs of the Government of Japan. A preparatory study team was dispatched to Malaysia in September 1998 and, subsequently, the Study was started in January 1999. It is scheduled for completion in May 2000.

1.2 Objectives of the Study

The Study is divided into Phase 1 and Phase 2. Phase 1 aims at delineating a long-term strategic plan of drainage improvement works up to the year of 2020, including the setup of a planning framework and the selection of priority projects. Phase 2, on the other hand, aims at carrying out the feasibility study on priority projects selected, including the preliminary design of facilities, economic evaluation and environmental impact assessment. Phase 2 also aims at preparing a guideline that prescribes all necessary work procedures and engineering standards for urban drainage improvement.

All study results of Phase 1 are compiled and presented in Part 1 of this Main Report, while those of Phase 2 are in Part 2. The objectives of the studies in Phase 1 and Phase 2 are as outlined below.

(1) Phase 1: Formulation of Drainage Structure Plan

The structural plans related to urban drainage improvement are formulated, including the following items:

- (a) Clarification of the present drainage condition of the study area;
- (b) Setting up of the planning framework such as regional development framework of the study area and the design level of urban drainage improvement;
- (c) Preparation of alternative urban drainage improvement plans;
- (d) Selection and formulation of the optimum plan including the institutional setup plan; and
- (e) Selection of the priority projects.

(2) Phase 2: Feasibility Study on the Priority Projects and Preparation of a Guideline for Urban Drainage Improvement

The principal objectives of the study are as given below:

- (a) Formulation of priority projects including preliminary design of facilities, cost estimation and the formulation of project implementation plans;
- (b) Project evaluation including economic evaluation and the environmental impact assessment (EIA); and
- (c) Preparation of a guideline for integrated urban drainage improvement in Malaysia.

1.3 Study Area

The study area for Phase 1 is divided into two areas, Sungai Petani and Melaka, which represent the regional centers in Malaysia (refer to the General Map). Among these study areas, Sungai Petani, covers six (6) rivers, Sungai Petani, Sungai Lalang, Sungai Tukan, Sungai Pasir, Sungai Che Bima and Sungai Layar Besar, which have a total catchment area of about 100 km². These rivers are the tributaries of Sungai Merbok, and their catchment areas are located in Kuala

Muda District of Keda State and administered under the Sungai Petani Municipal Council. As for Melaka, included are three (3) river basins, Sungai Melaka, Sungai Malim and Sungai Lereh, which have a total catchment area of approximately 192 km² that drain directly into the Melaka Strait. All of these rivers are located within Melaka Tengah District of Melaka State and administered under the Melaka Municipal Council.

1.4 Contents of the Report

The results of the Study are compiled in six volumes; namely, Volume 1, Summary; Volume 2, Main Report; Volume 3, Supporting Report on Drainage Structure Plan (Phase 1 Study); Volume 4, Supporting Report on Feasibility Study (Phase 2 Study); Volume 5, Technical Guideline; and Volume 6, Data Book. The Main Report (Vol. 2) gives a general presentation of the Drainage Structure Plan as well as the Feasibility Study. The brief on the contents of the Main Report is compiled in the Summary (Vol. 1). The Supporting Report (Vol. 3 and 4) is divided into several sectors (Sector I to IX) which present the details of the sector studies with supporting data compiled in the Data Book (Vol. 6). The Technical Guideline (Vol. 5) presents the proposed Technical Guideline for Urban Drainage Improvement.