CHAPTER 5. PROJECT EVALUATION

5.1 Economic Evaluation for Priority Projects

The urban drainage projects, if implemented, could reduce the extent and duration of the inundation and mitigate flood damage. To evaluate the economic viability of the projects for the priority areas, estimated is the economic internal rate of return (EIRR). The EIRR is based on the economic benefit derived from the flood damage reduction with the project and the economic cost required for the project.

5.1.1 Economic Benefit

Flood damage is classified into the direct and the indirect damages. Direct damage is brought by the direct effect of flood including damage to houses, household effects, commercial and industrial establishments, institutions, agricultural crops and infrastructure. The indirect damage is brought by the indirect effect of flood such as loss of household income, loss of earnings and overtime wage payment by commerce/industry due to stoppage of operation, which is called as loss of economic activities. The indirect damage could further extend to influence traffic, outbreak of waterborne epidemics, expenditure for rescue and relief, psychological sufferings, etc.

Among these various categories of flood damage, the direct flood damage other than agricultural damage is taken up as the objective of estimation in this Study. As for the damage to agricultural crops, there scarcely exist agricultural land in the objective study area, and therefore, agricultural damage is excluded from the objectives of estimation. The Study also highlights the loss of economic activities and traffic damage (among the indirect damages) as the objectives of estimation, because these could be enumerated as major and representative damages in the objective study areas.

The economic benefit is estimated by the difference between the average annual flood damage value prior to implementation of the project and the value after completion of the project. The estimation is premised on the following items:

(1) The proposed drainage improvement facilities are designed to cope with the target design level of 5-year return period flood. Accordingly, after completion of the proposed drainage improvement project, the priority areas will be free from the damage by probable floods of up to 5-year return period.

(2) The annual average flood damage will increase as the damageable assets increase due to land development in the possible flood inundation areas. From this point of view, estimated are the flood damage values under the present land use condition and the projected land use condition in 2020. The future flood damage by 2020 is assumed to grow at the annual average incremental rate between the present and the year 2020.

Based on the above premises, the annual average economic benefit for each of the priority areas is estimated as below:

(Unit: RM million/year)

Drainage Area	Annual Economic Benefit (at 1999 price level)	
	Under Present Land Use	Under Projected Land Use in 2020
Sg. Air Mendidih	972	2,415
Line-G	277	1,588
Prt. Pokok Mangga	2,141	8,968
Sg. Ayer Salak	2,658	16,015
Total	6,048	31,006

5.1.2 Economic Cost

The project economic cost is converted from its corresponding financial cost by reducing the price contingency from the financial cost and multiplying the following conversion factors with local currency portion of the financial cost.

Item	Conversion Factor	Estimation Base of Conversion Factor
Construction Cost	0.89	SCR x (1-TP)
Labor Cost	0.87	SCR x (1-TP) x OC-Land
Land Acquisition Cost	0.80	SCR x (1-TP) x OC-Labor
Administration and Engineering Cost	0.89	SCR x (1-TP)
Physical Contingency	0.89	SCR x (1-TP)

Note: SCR = Standard Conversion Rate assumed as 0.90
TP = Transfer Payment assumed as 0.10
OC-Land = Opportunity Cost of Land assumed as 0.90
OC-Labor = Opportunity Cost of Labor assumed as 0.97

As the results of the above conversion, the project economic cost is estimated as listed below:

Drainage Area	Economic Cost (at 1999 price level)	
	Construction Cost (RM million)	Operation and Maintenance Cost (RM million/year)
Sg. Air Mendidih	8,333	127
Line-G	5,109	94
Prt. Pokok Mangga	14,326	48
Sg. Ayer Salak	26,681	442
Total	54,449	711

5.1.3 Economic Evaluation

The cash flow for economic evaluation is made with the following assumptions:

(1) The economic benefit is assumed to increase in accordance with increase of the land value by the land development until year 2020.

(2) Partial benefit of the project are assumed to accrue during construction period in proportion to the progress of construction work, i.e., the benefits are estimated by a ratio of the invested construction cost to the total construction cost.

(3) The construction period and economic life of the proposed facilities is taken as 5 years and 50 years after completion of construction works, respectively.

Based on the cash flow as assumed above, the economic internal rate of return (EIRR) and other economic indices of the proposed drainage improvement project is as estimated below:

Objective Drainage Area	EIRR (%)	B/C at discount rate of 13%	NPV at discount rate of 13%
Sg. Air Mendidih	16.8	1.7	4,511
Line G	13.8	1.4	1,488
Prt. Pokok Mangga	25.7	2.6	22,125
Sg. Ayer Salak	20.8	3.3	31,561
Total	19.6	2.3	50,581

As shown above, the proposed drainage improvement for all priority drainage areas could generate the EIRR of more than the opportunity cost of about 13%. Thus, the projects are evaluated to contain economic viability.

5.2 Financial Evaluation for Priority Projects

The financial affordability for implementation of the proposed drainage projects in the priority areas are as evaluated below:

(1) Affordability of Construction Cost

The construction cost for the projects is estimated at RM 57.9 million in total. Out of the total cost, the construction cost of RM 2.5 million for the following five flood detention ponds could be borne to the Land Developer. Accordingly, the cost to be shared by the government budget is estimated at RM 55.4 million, which is to be disbursed for the next five-year period for 8th Malaysian Plan (2001 – 2005).

Name of Flood Detention Pond	Name of Drainage Basin	Type of Pond	Construction Cost (RM thousand)
1. Upper Line P	Sg. Air Mendidih	Dry Pond	329
2. Upper Line G	Line G	Wet Pond	467
3. Tg. Minyak (1)	Sg. Ayer Salak	Wet Pond	605
4. Upper Ayer Salak	Sg. Ayer Salak	Dry Pond	559
5. Middle AB 1	Sg. Ayer Salak	Wet Pond	536
Total			2,497

In comparison with the above required, the Federal DID has allocated a budget of RM 633 million for flood mitigation and drainage improvement during the recent five years from 1996 – 1998). Accordingly the above required cost of RM 55.5 million to be shared by the government corresponds to 8.8% of the five-year budget allocated to flood mitigation and drainage improvement.

Federal DID has allocated about 33.0% of the total budget for flood control and urban drainage to the objective states of Kedah and Melaka in the 5th Malaysian Plan (1986 – 1991) and 22.2% in the 6th Malaysian Plan (1991- 1995). The allocation is on the ad-hoc base, and therefore, the percentages allocated to each of the projects could fluctuate according to the necessity and urgency of flood control. Nevertheless, the percentages previously allocated for flood control projects to Kedah and Melaka are far larger than the above value of 8.8%. Judging from these, available budgetary conditions, it is concluded that the construction cost of the proposed projects for priority areas could be financially affordable.

(2) Operation and Maintenance Cost

The operation and maintenance cost for the proposed projects are estimated at RM 0.25 million for Sungai Petani and RM 0.58 million for Melaka as listed below:

Proposed Facilities	Maintained by	Annual Required Maintenance Cost (RM thousand)		
		Sungai Petani	Melaka	Total
River and Trunk Drains	DID	0.04	0.25	0.29
Flood Detention Pond	Local Authority	0.21	0.33	0.54
Total		0.25	0.58	0.83

In comparison with the necessary maintenance cost, the annual average budget allocated for flood mitigation and drainage to DID as well as the Local Authorities of Sungai Petani and Melaka in 7th Malaysia Plan are as enumerated bellow (refer to sub-section 1.5.1):

Federal D	:	RM 126.66 million
State DID (Kedah)	:	RM 0.70 million
State DID (Melaka)	:	RM 2.26 million
Local Authority of Sg. Petani	:	RM 0.65 million
Local Authority of Melaka	:	RM 6.48 million

As listed above, all necessary maintenance cost other than that to be shared by the Local Authority of Sungai Petani takes less than 10% of the allocated annual average budget and therefore, could be financially affordable. However, the maintenance cost to be shared by the Local Authority of Sungai Petani takes about 32% of the allocated budget, and difficulties are foreseeable in securing the maintenance cost. Such less budget for the Local Authority of Sungai Petani is attributed to the fact that no major drainage facility has been constructed in Sungai Petani. A major part of the budget for the Local Authority is dependent on the Federal Fund. Hence, the Local Authority of Sungai Petani should coordinate the Federal Government (i.e., the Ministry of Housing and Local Government) to secure the necessary maintenance cost.

5.3 Environmental Evaluation

The major environmental issues related to the proposed drainage improvement plan have been screened, and the eligible countermeasures are proposed and incorporated into the proposed plan.

5.3.1 Issues on House Relocation

Implementation of the project will require relocation of about 97 houses, as shown below:

Objective Drainage Area	Number of Relocation House
Sg. Air Mendidih	30
Line G	0
Prt. Pokok Mangga	29
Sg. Ayer Salak	38
Total	97

This estimation is on the premise of present land use conditions. The estimated number of house relocation would remarkably increase due to the projected intensive land development, unless proper and early arrangement of land acquisition is made. To smoothly execute the house relocation, the following measures are required:

(1) To gazette the reserve areas for implementation of the drainage improvement project and incorporate them into the Local Plan;

(2) To promote public awareness on the necessity of the drainage improvement project and enhance the agreement and cooperation of residents on project implementation.

5.3.2 Particular Issues on Rehabilitation and Construction of Flood Detention Ponds

The water quality of almost all existing flood detention ponds are seriously polluted. Domestic wastewater composed of sewage and sludge is a significant source of pollution especially in the town centres. To improve the domestic sewerage system, the Government of Malaysia had awarded the national sewerage privatization project to "Indah Water Konsortium (Indah Water)". A modern and separate sewerage system is going to be developed and managed through the services of Indah Water and this will prevent the polluted domestic sewage from flowing into the flood detention ponds. Thus, it is crucial to promote the services of Indah Water. At present, however, most of the study areas are served by individual septic tanks, and it is virtually difficult to immediately replace them with a new and separate sewerage system. Moreover, it is also difficult to control the effluent from industrial areas. Hence, a separate sewerage system is likely to be provided only to the new residential areas for the time being. To cope with this issue, the following considerations are required for the construction and maintenance of flood detention ponds:

(1) When the catchment of the flood detention pond includes a substantial extent of the existing built-up area where the inflow of polluted domestic wastewater is expected, the dry pond type with rubbish trap at the inlet is adopted. This type will minimize the polluted inflow into the ponds.

(2) Sustainable maintenance should be given to the ponds so as to desludge and clean the accumulated rubbish and scum.

(3) To control the industrial effluent, it is required to arrange the proper sites of industries and to screen the polluting industries. An attempt should also be given to the development of cleaner technology such as zero discharge of wastewater and good housekeeping practices.

5.3.3 Particular Issues on Channel Improvement

Dredging made as a part of the proposed drainage improvement will increase the channel flow capacity and at the same time clean the channel through removal of a large volume of sludge that contain organic materials. However, the sludge when removed by dredging may release a foul odor as well as gases, and the aquatic fauna and flora will absorb the organic materials. Moreover, the sludge once removed must be disposed at a proper site that will not cause further

environmental pollution. From this viewpoint, dredging should be made taking minimal impact on fishes and other aquatic life into account. Temporary diversion may be made, if dredging is required along a stretch sensitive to aquatic life. Toxicity and contaminants of dredged sludge should also be assessed. The sludge, if no toxicity is found, could be disposed offshore. The sludge could also be composted and used for agricultural purposes, or used as embankment materials, unless it contains inappropriate levels of sodium chloride or causes the emission of foul smell. In the event that the sludge material is found to be toxic, it should be disposed as hazardous waste through a company in Malaysia that is licensed to treat toxic waste.

Utmost effort should further be given to "natural river engineering" on channel alignment and embankment whereby wildlife conservation and natural beauty are enhanced. The natural river engineering should involve preservation of wet land or construction of flood retarding basins which will provide areas for aquatic fauna and flora to exist in large numbers and encourage the formation of a rich and stable ecosystem.

CHAPTER 6. CONCLUSION AND RECOMMENDATION

6.1 Structural Measures for Urban Drainage

6.1.1 Basic Concept on Urban Drainage Improvement and Implementation of Drainage Improvement Projects in the Priority Areas

The urban drainage improvement in the structural aspect could be made by a combination of (a) drainage channel improvement to increase the drainage discharge (called "quick disposal of flood") and (b) basin flood detention to decrease the flood peak runoff discharge (called "source control of flood"). In Malaysia, the major concerns have been given to the quick disposal of flood, while less concerns to the source control of flood. However, the disposal of flood contains the adverse effects as enumerated below:

(1) Most of the present river flow capacities are extremely low and could not cope with even the probable flood runoff discharge of a 2-year return period.

(2) Under such a condition, should the existing drainage channels be drastically enlarged in line with the quick disposal of flood, runoff from drainage areas in the upper reaches would concentrate to the downstream river channel and cause a more serious river overflow.

(3) Moreover, the on-going intensive land development in the study area will accelerate the overflow of drainage channels as well as their downstream river.

In order to avoid the above adverse effect, one of the crucial issues for urban drainage improvement should be given to the source control of flood so as to regulate and minimize the peak storm runoff discharge within the basin by various types of flood detention facilities.

In due consideration of the crucial issue as well as the economical and technical viability of alternative plans, ***the following optimum plans for the priority areas. are recommended to be implemented with the design flood level of 5-year return period and the target completion year of 2005.***

Drainage Area	Improvement Measures as Components of the Optimum Plan
Sg. Air Mendidih	1. Channel improvement of four (4) existing trunk drains (Total length: 4,440m). 2. Construction of on-site flood detention ponds at two (2) sites of public open spaces (Total Storage Capacity: 19,900m^3). 3. Construction of new flood detention ponds at three (3) possible sites.
Line-G	1. Channel improvement of one (1) existing trunk drain (Total length:3,020m). 2. Construction of one (1) new diversion channel (Total length: 4,440m). 3. Rehabilitation of the existing two (2) off-site flood detention ponds 4. Construction of new flood detention ponds at two (2) possible sites
Pokok Mangga	1. Channel Improvement of three (3) existing trunk drains (Total length: 8,280m). 2. Construction of one (1) new trunk drain which runs along almost center-line of the basin
Sg. Ayer Salak	1. Channel improvement of one (1) river channel and two (2) existing trunk drains (Total length: 16,740m). 2. Rehabilitation of one (1) existing flood detention pond 3. Construction of five (5) new flood detention pond

Channel improvement as well as the peak drainage discharge flowing into the downstream river could be minimized by the above proposed flood detention facilities. This advantage is, however, not expected to the drainage area of Prt. Pokok Mangga, where the land is a typical coastal plan area with the high ground water level, and it is virtually difficult to construct the flood detention facilities. Thus, the flood detention facilities without drainage channel improvement could not always perform the target design drainage improvement level depending on the physical conditions of the basin .

6.1.2 Application of Storage Tank in a House Lot for Drainage Improvement in the Densely Populated Area

The storage tank in a house lot is one of the flood detention measures. The storage tank is installed at a house lot to collect rainfall from the rooftop and a small outfall is provided at the side bottom to regulate the outflow discharge from the tank. The standard type of the facility is to have the storage volume of $2m^3$ for a unit house lot of $200m^2$ and a roof top area of $100m^2$. The installation cost of the storage tank is estimated at about RM 2,600 per house unit.

The storage tank in a house lot was not applied as a component of the proposed drainage improvement plan in the Study due to its higher installation cost than other alternative measures and difficulties in obtaining the individual agreement of house owners.

However, verified in the detailed hydrological study for the priority areas was a certain flood detention effect of the measure. Moreover, the measure does not require any house relocation and, the water stored in the storage tank could serve as secondary water resources. From this point of view, ***the measure should be applied to a densely populated area in particular, where no alternative drainage improvement measure other than the storage tank in a house lot is applicable. The subsidy system should also be established to encourage the house owners to install the facility.***

6.1.3 Countermeasures for Environmental Adverse Effect to Drainage Facilities

Water quality monitoring was carried out at 20 points in total for the four (4) priority areas. As the result, it was confirmed that suspended solids and organic wastes are the common significant pollutant sources of the existing drainage channels and flood detention ponds. Eutrophication of water by inorganic forms of phosphorous and nitrogen was also detected as another problem associated with water quality leading to massive algae blooms. The results of water quality monitoring are summarized below.

Parameter	Sg. Petani		Melaka	
	Sg. Air Mendidih	Line-G	Prt. Pokok Mangga	Sg. Ayer Salak
ph	4.5 – 6.7	5.8 – 6.8	6.5 – 7.6	3.9 – 6.8
BOD	3 – 35	2 – 26	2 – 42	4 – 17
COD	13 – 139	13 – 104	10 – 141	13 – 96
SS	10 – 90	12 – 52	8 – 932	10 – 602

Note: No significant content of toxic compound of heavy metals was detected.

To cope with the above environmental adverse effects to the drainage facilities, the following countermeasures should be taken:

(1) When the catchment of the flood detention pond includes a substantial extent of the existing built-up area where the inflow of polluted domestic wastewater is expected, the dry pond type with rubbish trap at the inlet should be adopted. This type will minimize the polluted inflow into the ponds.

(2) Sustainable maintenance should be given to the ponds so as to desludge and clean the accumulated rubbish and scum.

(3) To control the industrial effluents, it is required to arrange the proper sites of industries and to screen the polluting industries.

(4) The sludge dredged from the drainage channel, if no-toxicity is found, could be composted and used for agriculture purpose, or used as embankment materials. In the event, that sludge is found to contain the toxic materials, it should be disposed as hazardous waste through a company in Malaysia that is licensed to treat toxic waste.

6.1.4 Use of Flood Detention Pond as Amenity Space and Preservation of Wet Land

The proposed flood detention ponds are designed either as dry pond, wet pond or wet land. Among them, the dry pond does not allow impounding of water in the pond during the non-flooding time, while both of the wet pond and the wet land continue to impound water even during non-flooding time. The difference between the wet pond and the wet land is that the wet pond is enhanced as an artificial pond through extensive excavation work. On the other hand, the wet land is applied to the existing natural swampy area on the premise of minimum earth works so as to preserve the present natural conditions.

All wet ponds is provided with an amenity space around the impounding space, and some dry ponds are also used as community pond, provided that they are placed in a rather extensive vacant space where large scale amenity facilities could be provided. ***These amenity functions could contribute to the improvement of urban environment and therefore should be applied to the future drainage improvement projects. At the same time, an attempt should be made***

to maintain the existing swamp area as wet land to preserve the natural flood retarding effect and the natural ecological system as proposed.

In the drainage improvement plan for the priority areas, proposed are the ten (10) flood detention ponds which are classified into five (5) dry type ponds, four (4) wet type ponds and one (1) wet land as listed below:

Drainage Area	Name of Pond	Name of Downstream Trunk Drain	Pond Type
Sg. Air Mendidih	1. Police Hutan	Line-P	Wet Pond
	2. Upper Line-P	Line-p	Dry Pond
	3. Line-N	Line-N	Dry Pond
Line-G	1. Upper Line-G	Line-G	Wet Pond
	2. Middle Line-G	Line-G	Dry Pond
Sg. Ayer Salak	1. Tg. Minyak (1)	Sg. Ayer Salak	Wet Pond
	2. Upper Ayer Salak	Sg. Ayer Salak	Dry Pond
	3. Tg. Minyak (2)	Prt. AB-1	Wet Pond
	4. Middle AB-1	Prt. AB-1	Wet Land
	5. Middle AB-11	Prt. AB-11	Dry Pond

6.2 Non-structural Measures for Urban Drainage Improvement

The following restructuring of the existing organization set-up for urban drainage improvement is recommended.

6.2.1 Establishment of Interagency Coordination Bodies at Federal and State Level

In order to enhance the consistent urban drainage improvement in Malaysia, the interagency coordination bodies are required at both of Federal and State Level. From this viewpoint, establishment of the new coordination bodies as well as application of the existing coordination bodies are proposed as enumerated below:

(1) Establishment of the New National Rivers Council (NRC) at Federal Level

There is recent proposal to establish a National Rivers Council (NRC) with its secretariat at Federal DID to deliberate and formulate the policies and programmes on the nation-wide river management which includes the matters on the flood control and urban drainage. In this connection, ***it is recommended to establish the NRC as the most appropriate platform at Federal Level to undertake formulation of the uniform policies on urban drainage improvement for all states.***

(2) Application of the Existing State Planning Committee at State Level

There is a existing coordination body called State Planning Committee (SPC) at State Level. The SPC deliberates the formulation of policies on the conservation, development and use of all land in the State. The on-going intensive land development in the study area would cause a rapid increment of peak storm runoff discharge, while the urban drainage improvement may hardly catch up with the rapid

increment of discharge. To avoid such unbalance, ***the SPC should be the forum to coordinate projections on land development and the urban drainage. Moreover, the State Director of DID should be made a permanent member of SPC so as to take technical responsibility on river management and urban drainage.***

(3) State Water Management Authority (SWMA) at State Level

The SWMA is recently proposed as the interagency coordination body among the agencies related to the river management and urban drainage at State Level. ***It is recommended that the SWMA should be established to coordinate the drainage management plans that emanate from the State DID and/or Local Authority in order to promote a consistent drainage improvement plan. At the same time, the SWMA should coordinate with NRC to enhance the consistent drainage improvement policies between Federal and State Levels.***

6.2.2 Demarcation of Functional Responsibility for Drainage Improvement

The drainage improvement works involve the planning, design, construction and operation/maintenance for various drainage facilities which cover the river and drainage channel, flood detention pond and other various on-site flood detention facilities. According to the present guideline and regulations, DID and the Local Authority are the major executive bodies for drainage improvement works. However, due to the lack of clear demarcation of the works between DID and the Local Authority, the consistent drainage improvement is hardly executed. ***In order to retrieve such unfavourable conditions, the demarcation is proposed as listed below:***

Drainage Facility	Planning/Design/Construction	Maintenance
1. Basin-wide Drainage Facility		
1) River Channel Improvement	DID	DID
2) Trunk Drain	DID	DID
3) Community Flood Detention Pond	DID	LA
2. Sub-basin Drainage Facility		
1) Infrastructure Drain/Secondary Drain	LD/LA	LA
2) Roadside Drain (Sate/Federal Road)	PWD	PWD
3) Road Drain (Municipal Drain)	LD	LA
4) Perimeter/Tertiary Drain	LD	LA
5) Off-site Flood Detention Pond	LD	LA
6) On-site Detention Facility in Public Space	LA	LA

Note: LA: Local Authority; D: Land Developer; PWD: Public Works Department

6.2.3 Capacity Building of Local Authority

As stated above, the Local Authority shoulders the extensive responsibilities on the drainage improvement, and the responsibilities will significantly expand as the urbanization progresses very rapidly. In spite of the extensive responsibility on the drainage improvement, both Local Authorities of Sungai Petani and Melaka are suffered from a lack of qualified technical

manpower, and there does not exist even a drainage division within their Engineering Department. In order to retrieve this unfavorable situation, ***it is required to promote the plan for reinforcement of the present capacity building of Local Authority into more practical programmes through deliberations among the related departments and agencies.***