8.2 Proposed Institutional Setup Plan

The proposed organization for management of the RBIS is composed of tiers with the RBIS Steering Committee as the top supported by the RBIS Technical Committee as the second level and the RBIS Technical Center as the third level. The formation, roles, composition and functions of each tier are as described hereinafter.

8.2.1 Steering Committee

In Malaysia, information technology is being intensively developed and information is being opened through the wider area network. In fact, the RBIS has already been equipped with a wide area network communication system. Moreover, the National Land Information System (NaLIS) and Hydrological Information System (HIS) are going to develop their wide area communication services for land information and hydrological information, respectively. Such progressive information technology will facilitate easy and effective data communication but at the same time, generate several issues as enumerated below:

(1) Protection of data confidentiality and/or copyright;

(2) Standardization and synthesis of the related information systems so as to create interchangeability among the systems;

(3) Development of human resources to cope with the advanced information technology; and

(4) Import of progressive information technology.

The RBIS involves various kinds and levels of government and semi-government agencies as information sources. Accordingly, the above items are significant issues on the management of the RBIS, and the Steering Committee will determine the policies to cope with the issues and provide the guidelines/directions on utilization of the objective information through coordination with the related government agencies. The Steering Committee will also monitor the national policies on information technology through activities of the following related national councils and committees and reflect them in the management of information of the RBIS.

Name of Council and Committee	Tasks Related to Management of RBIS
(1) National Land Information System (NaLIS) Central Council	• Formulate policies on development, implementation and operation of National Land Information System.
(2) National Information Technology Council (NITC), and National Committee on Database Processing (NCDP)	• Formulate policies, strategies and standards of utilization and development of information technology (IT). • Monitor and evaluate the programs, projects and activities pertaining to use and development of IT. • Enhance and encourage the use and development of IT.
(3) National Remote Sensing Committee (NRSC)	• Formulate national policy on remote sensing technology.
(4) National Mapping Committee	• Coordinate and advice all mapping and charting activities undertaken by government agencies.

The information center of the RBIS is placed at the Federal DID under the Ministry of Agriculture, and all information is provisionally collected and/or provided through the existing wide area network called "Agrolink" which is under the control of the Ministry of Agriculture. Thus, the Ministry of Agriculture is the core ministry for the RBIS. Due to this background, the Secretary General of the Ministry of Agriculture is proposed as the chairman of the Steering Committee, and the Secretariat of the Committee is further proposed to be the Information Technology Unit of the Ministry of Agriculture and the River Division of Federal DID. The members of the Steering Committee will be the representatives of the government agencies which are closely related to the formulation of national policy on information technology (refer to Table 8-1).

8.2.2 Technical Committee

Based on the aforesaid policies formulated by the Steering Committee, the Technical Committee will determine all technical standards to prescribe the management of the RBIS. At the same time, the Committee will undertake all technical monitoring and evaluating works required to manage the RBIS Technical Center. The detailed tasks of the Technical Committee are as given below:

(1) To determine and update the format, procedure and all other necessary technical arrangement for data input/output through coordination with the information sources and users of the RBIS;

(2) To determine and update all necessary protocols for data communication;

(3) To determine the mechanism of system use charges;

(4) To evaluate and approve the technical manual on daily system management prepared by the Technical Center;

(5) To monitor the information technologies practiced in Malaysia as well as import them to the management of the RBIS; and

(6) To evaluate the accessibility, availability, quality and effectiveness of information and reflect the results of evaluation to the management of the RBIS.

The Technical Committee will be chaired by the Director General of DID, who will also be responsible for all systems operation and management. The River Division of Federal DID will act as the Secretariat to the Committee. The members of the Committee will consist of all government and semi-government agencies designated as information sources and/or users of the RBIS (refer to Table 8-2).

8.2.3 Technical Center

The Technical Center is placed at the office of the River Division of Federal DID, and its sub-center is placed at State DID in Perak. The task of the Technical Center is to undertake all necessary operation and maintenance of hardware, software, and database of the RBIS. The Technical Center will also service the system users, supplying newsletter and highlighting the latest developments in functions of the RBIS so as to advertise the RBIS. As for the branch center at State DID, its task is to operate and maintain the telemetry data management system.

To ensure the effective daily operation and maintenance, the following staff should be engaged as a minimum requirement:

(1) One River Engineer, one Network Manager, one Database Manager and Digitizer Operator at the Technical Center in Kuala Lumpur; and

(2) One Systems Operator for the telemetry data management system at the Technical Sub-center in Perak State.

All of the staff will need particular knowledge on the system operation. Among the staff, the River Engineer and the Network Manager, in particular, will have the most important role of taking care of the whole system. The other staffs will take part in management work; that is, the Database Manager will be in charge of database management, the Digitizer Operator will undertake the actual digitizing works for various map information, and the Systems Operator will operate and maintain the telemetry management system in the sub-center at the State DID of Perak. Thus, the Technical Center will undertake daily systems operation and

management. The major items for the daily operation and maintenance are as enumerated below:

(1) To periodically update the database;

(2) To revise the database structure in order to expand the items of information in the database upon instruction from the Technical Committee;

(3) To update the web homepages in accordance with the revision of contents of the database and/or real-time information;

(4) To update the arrangement of the system IP addresses in accordance with the altered system users and/or request from the Agrolink network manager;

(5) To review and revise the "System Management and Operation Manual" which has been initially prepared by the JICA Study Team and to prepare the revised technical manual for approval of the Technical Committee;

(6) To operate the web servers both for database and the real-time information as required;

(7) To undertake system troubleshooting referring to the "System Management and Operation Manual"; and

(8) To entrust the recovery of fatal system damage to a professional engineering firm.

8.3 Alternatives to the Composition of the Management Body of RBIS

The RBIS proposed in this Study limits its objective coverage only to the Perak river basin, although the ultimate goal is to have a nationwide coverage. Thus, proposed is a prototype system and the composition of the management body as proposed above is practicable and easy to set up in such a prototype system. However, the set-up may need to be modified depending upon the situation, and the following alternatives are conceived:

(1) Alternative 1

As the objective river basins for the RBIS expands, the Federal and State members of the management body will increase as data sources and/or data users. Under such condition, coordination among all members would be very important for the management of RBIS. The Economic Planning Unit (EPU) would be highlighted as

the central coordination body for those related to river basin development and water use and serve as the forum for central policy and decisions on river basin management. Based on this concept, the Chairman and Secretariat of the Steering Committee during the transition period of expansion should come from the Federal Economic Planning Unit.

To clarify and cope with the requirements of various state agencies, a Technical Committee will need to be established at the Federal and in each State Level. The Chairman and Secretariat of the Technical Committee will be drawn from the Federal EPU and the State EPUs (UPENs). Such a set-up would ensure a closer relationship between the Federal and State governments and, at the same time, facilitate coordination among DID, PWD, DOE and other various Federal and State agencies involved in water use.

The Technical Center and its Sub-center are placed, for the present, at the Federal DID in Kuala Lumpur and the State DID of Perak, respectively. During any transition period of expansion of RBIS, the Technical Center would be maintained by Federal DID, while Technical Sub-centers would be established in each State DID that comes within the coverage of the RBIS.

(2) Alternative 2

Both NaLIS and RBIS aim at providing the on-line access to land and river basin information, respectively, as index of national resources, and the major users of such information are the State governments. Thus, NaLIS and RBIS are closely related to each other, and a consistent institutional setup for NaLIS and RBIS could facilitate a more effective usage of the information.

To maintain consistency with the organization of NaLIS, the Prime Minister is conceived as the Chairman of the Steering Committee under the RBIS as proposed in NaLIS. Likewise, the Secretariat of RBIS is entrusted to the Ministry of Agriculture, the technical core agency of RBIS. As the Technical Committee of RBIS, the Chairman and the Secretariat are to be the Federal DID at the Federal level and the State DID at the State level. The setup of the Technical Center will be in accordance with those proposed in Alternative 1.

(3) Alternative 3

The Ministry of Agriculture is looking into the setting up of the National River Authority. Upon establishment, the Authority will oversee the nationwide river basin management. In the "Pilot River Basin Management Study of Selangor River" by the State DID of Selangor, also proposed was the Selangor River Authority (SRA) to undertake actual monitoring and coordinating works for the river basin management. The Study may implicate a model of the institutional setup for individual river basin management. Several state river authorities like SRA may be established, one for each river basin, and the National River Authority will have jurisdiction over such state river basin management bodies.

The RBIS will have the role to provide the necessary river basin information to the National River Authority as well as the State River Authorities. To facilitate such a role, it is proposed that the Chairman and Secretariat of the Steering Committee should be given to the Prime Minister and the National River Authority, respectively.

As for the Technical Committee, the Federal Committee and the State Committee will be established as proposed in Alternatives 1 and 2. As in the Steering Committee, the Prime Minister and the National River Authority will act as Chairman and Secretariat of the Technical Committee at the Federal Level, while Menteris Besar and the State River Authorities will be the Chairman and Secretariat of the Technical Committee at the State Level. The membership of the Technical Committee will involve all agencies designated as data sources and/or data users of the RBIS. The National River Authority also will have jurisdiction over the Technical Center for RBIS, and a Technical Sub-center will be established in each State, controlled by the State River Authority.

This Alternative is subject to establishment of the National River Authority. However, the setting up of the Authority will require further time since the existing legislation and policies need to be reviewed and revised. Moreover, this Alternative may need to be modified according to the condition of NaLIS. Thus, this Alternative is regarded as an ultimate setup for the RBIS management and to be examined in the far future.

is regarded as an ultimate setup for the RBIS management and to be examined in the far future.

9. CASE STUDY ON THE USE OF RBIS FOR RIVER BASIN MANAGEMENT

A case study was carried out to further clarify in detail how the RBIS's information could contribute to the actual river basin management. At the same time, estimated was the economic benefit associated with the contribution of the RBIS to river basin management.

9.1 Water Supply Management

9.1.1 Long-term Projection of Water Supply

TNB agreed with DID in 1975 that the existing hydropower dams will release discharge to guarantee a minimum flow of 4,000 cusec (about 113.2 m^3/s) at Iskandar Bridge which is located on the Perak River at about 23 km downstream from the Chenderoh Dam (refer to Fig. 9-1). Since all major intake points of the Perak River are located in the lower reaches from Iskandar Bridge, the guaranteed discharge is indispensable for sustainable water supply management for the Perak river basin. The guaranteed discharge was, however, set up more than 20 years ago, and the water demand will certainly exceed the guaranteed discharge in the future due to intensive increment of domestic and industrial water demand in particular. Under such circumstances, a serious water shortage may suddenly come out in the future unless a long-term projection on water supply and water demand is made.

The long-term projection on water supply and demand is, however, virtually difficult without database information on the integrated water demand volume and water supply capacity both for irrigation and domestic/industrial water supply. Since the RBIS contains such comprehensive database information, the overall water demand and supply balance could be estimated. According to the estimation as tabulated below, the future domestic and industrial water demand will have a remarkable increment; while, no new extensive irrigation scheme is projected and, therefore, the increment of irrigation demand is estimated to be nil.

Item of Demand	Present Water Demand	Future Water Demand		
		2005	2010	2020
Domestic and Industrial	15.8 m^3/s	21.5 m^3/s	25.5 m^3/s	43.4 m^3/s
Irrigation	31.6 m^3/s	31.6 m^3/s	31.6 m^3/s	31.6 m^3/s
River Maintenance	65.8 m^3/s	65.8 m^3/s	65.8 m^3/s	65.8 m^3/s
Total	113.2 m^3/s (4,000 cusec)	118.9 m^3/s (4,201 cusec)	122.9 m^3/s (4,343 cusec)	140.8 m^3/s (4,975 cusec)
Percentage of demand to annual average river flow at Iskandar Bridge*	59%	62%	64%	73%

* The annual average flow discharge at Iskandar Bridge is estimated at 192 m^3/s from the hydrological data gauged before dam construction (1961-1977).

The guaranteed discharge could ensure meeting the total of present domestic/industrial water demand and irrigation water. The balance of 65.8 m^3/s between water demand and guaranteed discharge is regarded as river maintenance flow.

Difficulty in abstracting the river water by pump is now being experienced due to the low river water stage during the drought period. Judging from such difficulty, the river maintenance flow of 63.5 m^3/s is regarded as the minimum requirement even in the future as assumed above.

As a result, the future water demand exceeds the present guaranteed discharge, and the deficit of about 1,000 cusec is foreseen by the year of 2020. Moreover, the future water demand will reach 73% of annual average river flow discharge in 2020. Thus, an extremely high rate of water utilization is estimated.

The River Administrator is required to update the projection on future water demand through continuous monitoring and periodical renewal of the database of water demand in accordance with the results of monitoring. Based on the projection on water demand, the River Administrator is further proposed to have the following water supply management:

(1) Coordination with TNB to increase the guaranteed discharge from existing dams;

(2) Coordination with water users to control the excessive increment of water demand; and

(3) New water resources development.

9.1.2 Daily Water Supply Management

The DID Hydrology Division presently monitors the daily flow discharge at Iskandar Bridge. The gauged discharge is, however, not transmitted to TNB. Since TNB could not monitor the

flow discharge at Iskandar Bridge, it releases a maintenance discharge of 3,000 cusec (about 85 m^3/s) from Chenderoh Dam regardless of river flow discharge at Iskandar Bridge. The dam maintenance discharge of 3,000 cusec is verified through the gauging records as shown in Table 9-1 and Fig. 9-2.

There is a balance of 1,000 cusec between the guaranteed discharge of 4,000 cusec at Iskandar Bridge and the maintenance flow of 3,000 (85 m^3/s) cusec from Chenderoh Dam. The balance is supposed to be supplemented by the runoff discharge from the Pelus River that joins to the Perak River at about 9 km downstream from the Chenderoh Dam. However, the runoff discharge from the Pelus River is a natural phenomenon, falling often below 1,000 cusec (23.8 m^3/s) (refer to Table 9-1 and Fig. 9-3).

The gauging records show that a dominant deficit of the guaranteed discharge at Iskandar Bridge occurred from August to September 1990 (refer to Table 9-2 and Figs. 9-4 to 9-5). During the period, the Chenderoh Dam had certainly released the dam outflow discharge of more than 3,000 cusec, while the runoff discharge from the Pelus river basin was far lower than 1,000 cusec. As a result, the deficit continued for a period of about one month, having the average deficit of 6 m^3/s and the maximum deficit of 20 m^3/s (refer to Table 9-2 and Fig. 9-5).

The recurrence probability of the 1990's water deficit is estimated at about 5 years based on one-month runoff discharge volume from Pelus River in August (refer to Fig. 9-6). In other words, the water deficit of Pelus River as experienced in 1990 possibly occurs once in every five years.

The above water deficit is attributed to lack of integrated hydrological monitoring system between DID and TNB. To cope with such an unfavorable situation, the RBIS is equipped with a function to monitor the river flow discharge of Perak River at Iskandar Bridge and Pelus River at Kg. Lintang. At the same time, the RBIS could also monitor the outflow discharge from Chenderoh Dam. All of these monitored data are on the real-time base being transmitted through WAN to the system administrator (DID) as well as related agencies such as TNB and PWB (in charge of domestic and industrial water supply).

When the RBIS detects that the runoff discharge from the Pelus River falls below 1,000 cusec, the dam outflow discharge of 3,000 cusec is to be increased so as to guarantee the river flow discharge at the Iskandar Bridge. In contrary, TNB does not necessarily need to release the discharge of 3,000 cusec when the runoff discharge from the Pelus River is

sufficient, exceeding 1,000 cusec. Thus, the RBIS enables TNB to operate a more flexible dam outflow depending on the runoff discharge from the Pelus River.

TNB is much concerned in maintaining the reservoir level for the sake of hydropower generation, although the reservoir level may be lowered due to incremental dam outflow discharge for water supply. In this connection, an attempt was made to simulate the necessary dam outflow discharge as well as dam reservoir level that could guarantee the discharge of 4,000 cusec in the case of the aforesaid deficit in 1990. The results of simulation are as shown in Table 9-3.

As shown in Table 9-3, during the deficit, Chenderoh Dam had released 92.5 m^3/s (3,268 cusec) as daily average. On the other hand, the average dam outflow discharge increased to 94.4 m^3/s to offset the deficit.

The increment of dam outflow discharge will be made by releasing discharge from the Temengor dam reservoir that is by far larger than those of the other three dams. The consumption of dam reservoir volume is estimated at 5,440,600 m^3 which corresponds to only 0.4% of the live storage volume, lowering 11 cm of reservoir level. Thus, the increment of the dam outflow discharge will cause a minimal effect on the dam reservoir level as well as power generation.

As described above, the water deficit in 1990 lasted for about one month and the daily average deficit during the period is estimated at about 6 m^3/s. Such water deficit will directly cause a deficit in irrigation water supply leading to the reduction of paddy production. From these viewpoints, an attempt was further made to estimate the production loss of paddy that corresponds to the average deficit of 6 m^3/s in 1990. For the estimation, the following assumptions were made:

(1) The average yield of paddy crop is estimated at 3.6 ton/ha with reference to the results of the Study on "Modernization of Irrigation Water Management System 1998", by JICA. The economic farm gate price is also assumed at about RM 630/ton. Multiplying the average crop yield by the economic farm gate price, the gross production value is estimated at RM 2,268/ha, while the paddy production cost is estimated at RM 1,805/ha. The unit net production value of paddy is expressed as the balance between the gross production value and the production cost and, therefore, estimated at RM 463/ha.

(2) The available irrigation area for a unit of water supply is about 604 ha/m^3/s which comes out from the present total irrigation area (19,097 ha) divided by its monthly peak water demand (31.61 m^3/s) in the Perak river basin.

Based on the above assumptions, the production loss of paddy that corresponds to the average deficit of 6 m^3/s in 1990 is estimated at about RM 1.7 million. The recurrence probability of the water deficit in 1990 is estimated at 5-year return period as described above and hence, the annual average value of the production loss is estimated at RM 0.34 million (i.e., RM 1.7 million in 5 years).

The RBIS enables TNB to have a flexible dam reservoir operation so that the occurrence of water deficit as experienced in 1990 could be justified by a release from the existing hydropower dam with its minimal reduction of power generation. Accordingly, the average value of production loss (RM 0.34 million) could be regarded as the annual average economic benefit of the RBIS.

9.2 Flood Management

9.2.1 Flood Control by Existing Hydropower Dam

The three (3) existing hydropower dams, namely, Bersia, Kenering and Chenderoh, currently have gate operation to maintain their reservoir levels at FSL (full supply level) even during the flood season (October to January) and, therefore, have no substantial flood mitigation effect. In contrast, Temengor Dam draws down its reservoir level from its FSL of EL. 248 m (reservoir volume of 6,050 million m^3) to EL. 242 m (reservoir volume of 5,100 million m^3) during the flood season to make a flood storage space of 950 million m^3.

The probable flood dam inflow hydrographs into the Temengor Dam were estimated based on the previous study results of "Lower Perak Flood Mitigation Study, October 1980" by JICA (refer to Fig. 9-7(1/2)). As a result, it was clarified that the flood storage space (950 million m^3) of Temengor Dam could absorb the whole flood inflow volume of less than a 20-year return period flood without spilling out as tabulated below.

Probable Flood Inflow Volume to Temengor Dam

Return Period of Flood	Dam Inflow Volume (million m^3)
10-year	564
20-year	843
50-year	1,276
100-year	1,587

The present flood inundation of Perak River tends to spread out in the lower reaches of Nording Bridge, when the river flow discharge at Nording Bridge exceeds 850 m^3/s. Nording Bridge is located on Perak River at about 187 km downstream of Temengor Dam. On the premises of the above flood mitigation effect of Temengor Dam, the flood simulation was made and, the following are estimated as the probable flow discharge at Nording Bridge.

Probable Flood Discharge at Nording Bridge

Return Period of Flood	Flow Discharge (m^3/s)
10-year	1,725
20-year	2,033
50-year	2,727
100-year	3,621

As shown above, the estimated probable discharge exceeds the critical discharge of 850 m^3/s at Nording Bridge. Thus, in spite of the extensive flood mitigation effect of Temengor Dam, flood inundation still occurs in the lower reaches of the Perak River. In fact, the flood inundation had occurred even after completion of the Temengor Dam, as experienced in 1985, 1991 and 1994.

To cope with the above flood inundation, an attempt was made to evaluate whether the current gate operation rule of the other three dams (Bersia, Kenering and Chenderoh) could be changed so as to draw down the reservoir level in advance of the flood and to effect flood mitigation for the lower reaches.

Among the existing hydropower dams, Bersia Dam which is located just downstream from Temengor Dam has a small reservoir volume of about 12 million m^3 between FSL and MSL (minimum supply level) and, therefore, minimal potential flood mitigation effect is expected of the dam. On the other hand, the Kenering and Chenderoh dams have rather large storage capacities of about 70 million m^3 and 60 million m^3 between FSL and MSL, respectively. These storage capacities are likely to influence the flood mitigation in the lower reaches.

To activate such a potential flood control capacity, it is indispensable to release the discharge and draw down the reservoir level from FSL during the initial stage of flood. Moreover, the released discharge to draw down the reservoir level should not cause any overflow at the lower stretch from the dams.

Temengor Dam spills out discharge in case of the probable flood discharge of more than 50-year return period. Such spilled discharge causes a large constant dam inflow discharge of more than 600 m^3/s into Kenering Dam [refer to Fig. 9-7 (2/2)]. The inflow volume into Kenering Dam is estimated at about 533 million m^3 in 50-year return period, and about 853 million m^3 in 100-year return period, which are far larger than the reservoir capacities of the Kenering and Chenderoh dams. Due to such large constant dam inflow discharges, both the Kenering and Chenderoh dams hardly draw down their reservoir level, having no substantial flood mitigation effect on the flood scale of 50 and 100-year return period.

As for the flood scale of 10 and 20-year return period, however, Temengor Dam absorbs the whole dam inflow discharge without spilling. Due to such effect of Temengor Dam, the small discharge flows into Kenering Dam. The dam inflow volume is estimated at about 143 million m^3 of 10-year return period and 165 million m^3 of 20-year return period. These dam inflow volumes are far smaller than the 50 and 100-year return periods.

Moreover, the initial dam inflow discharge to Kenering Dam is extremely small, and the peak inflow comes out only 72 hours after the storm rainfall is observed. Due to the small dam inflow volume as well as the time lag of peak dam inflow, the Kenering and Chenderoh dams could draw down their reservoir levels in advance to have a flood control space of about 260 million m^3. This flood control space could have a significant reduction in peak discharge at Nording Bridge, as shown in Figs. 9-8 to 9-10.

The above flood mitigation effects of the Kenering and Chenderoh dams are subject to lowering of dam reservoir level in advance before a flood arrives to their dam reservoirs, and the real-time information on the rainfall and river flow discharge is indispensable. Hence, the RBIS will be useful to monitor and disseminate such real time information.

The RBIS functions to monitor the real-time flood information on storm rainfall, river flow of downstream, and dam outflow discharge from the Chenderoh Dam. Furthermore, the RBIS disseminates such information, through WAN, to TNB as well as DID. Once these information are recognized through the RBIS, DID could clarify the allowable discharge, on real-time base, to be released from Chenderoh Dam in due consideration of the channel flow capacity as well as the runoff discharge from the Pelus River (i.e., non-dam catchment area).

Based on the clarification by DID, TNB could release the discharge and draw down the reservoir level so as to make a flood control space during an initial stage of flood until the dam inflow discharge reaches a certain level. After drawing down the reservoir level, the dam could start to store the flood inflow discharge so as to reduce the river flow discharge in the downstream.

Thus, TNB and DID could exchange dam reservoir information and hydrological information through the RBIS. As a result, the dam outflow discharge is effectively controlled for the sake of flood mitigation in the lower reaches. Moreover, DID could foresee the influence of dam outflow to the downstream based on the information on dam conditions from TNB so as to undertake a more effective flood forecasting and warning.

9.2.2 Evaluation of Flood Damage Potential

In the flood management works, major concerns are addressed to the flood damage potential, an essential index for economic evaluation for new flood mitigation projects. Database of the RBIS would facilitate estimation of the annual average damage expressed in a monetary value. The use of database to estimate the flood damage potential is hereinafter presented together with the results of estimation.

(1) Extent of Flood Inundation Area and Estimation of Land Use within the Area

Floods of the Perak River start to spread out in the lower reaches from Nording Bridge when the river flow discharge at Nording Bridge exceeds 850 m^3/s. Inundation of varying flood scales has almost the same extent due to the plain topography, although the maximum inundation depth and duration of inundation changes according to the scale (refer to Fig. 9-11).

The RBIS would furnish the map information on flood inundation extent as well as land use on the basis of the topographic map of 1 is to 50,000. Both maps are supported by the Geographic Information System (GIS) and, therefore, the land use within the extent of flood inundation could be easily clarified through overlaying the two maps. Through overlaying of maps, the area of each land use item could be estimated as below.

Land Use within the Extent of Flood Inundation
of Perak River

Land Use Item	Area within the Extent of Flood Inundation (ha)
Paddy	1,543
Rubber	4,451
Oil Palm	57
Other Tree Crops	2,696
Mix Horticulture	40
Forest, Swamp, Grassland	4,289
Total	13,076

(2) Estimation of Number Houses in Flood Inundation Area

The RBIS contains the database of housing census by Mukim (i.e., minimum administrative unit) as well as the GIS information on boundaries of Mukim and the probable flood inundation area. The number of houses in the flood inundation area could be estimated through the overlay function of the GIS system in the RBIS using the database and the GIS information (refer to Fig. 9-12). The results of estimation are as given below.

Estimation of Number of Houses in Flood Inundation Area

Name of Mukim	Average Housing Density (houses/km^2)	Area to be Inundated (km^2)	Number of Houses in Inundation Area
Lanu Kubong	26.54	0.05	1
Bandar	17.02	14.88	253
Bota	21.40	9.02	193
Kampong Gajah	26.15	10.78	282
Lambor Kanan	20.98	19.89	417
Lambor Kiri	9.90	4.19	41
Pasir Panjang Hulu	6.68	20.97	140
Pasir Salak	15.97	10.35	165
Pulau Tiga	7.81	40.63	317
Total	16.28	130.76	1,811

(3) Estimation of Probable Flood Damage Value

The probable flood damage value could be estimated through the following formula.

$$D_{(i)} = \bullet\{(Q_{(i)} \times UV_{(i)} \times F_{(i)})\}$$

Where;

$D_{(i)}$: Probable flood damage of i-year return period

$Q_{(j)}$: Quantity of damageable assets

$UV_{(j)}$: Unit value of damageable assets

$F_{(j)}$: Damage factor of damageable assets

The damageable assets cover the agricultural assets and housing assets, and their damageable quantity ($Q_{(j)}$) was given from the above area of land use within the flood inundation area. The unit value of damageable assets ($UV_{(j)}$) was also estimated from the current market prices. Moreover, the damage factor ($F_{(j)}$) was assumed with reference to the following previous study results:

(a) The relationship between the flood damage factor and the maximum flood inundation depth/flood duration is given from the "National Water Resources Study, Malaysia, October 1982" by JICA (refer to Table 9-4).

(b) The relationship between the peak flood discharge at Nording Bridge and the maximum flood inundation depth is given from the "Tumboh Block Integrated Rural Development Study, Flood Investigations, May 1985" (refer to Fig. 9-13).

(c) The flood duration is estimated as the duration of river flow discharge at Nording Bridge over 850 m^3/s as described in "Tumboh Block Integrated Rural Development Study, Flood Investigations, May 1985".

The probable flood hydrographs at Nording Bridge were estimated, as described above, assuming the present dam operation rule as well as the revised operation rule for the Kenering and Chenderoh dams (refer to Fig. 9-10). The maximum inundation depth/flood duration was given from the probable flood hydrographs and, as a result, the probable flood damage values were estimated as shown in Tables 9-5 and 9-6.

(4) Annual Flood Damage Value

The annual flood damage value is estimated through the following formula:

$$D_{ave} = \bullet\{ D_{(i)} \times P_{(i)} \} dP \cong \bullet\{(D_{(i-1)} + D_{(i)}) /2 \times (P_{(i-1)} - P_{(i)})\}$$

Where;

D_{ave} : Annual average flood damage value

$D_{(i)}$: Probable flood damage value of i-year return period

$P_{(i)}$: Occurrence probability of i-year return period

The results of estimation are shown in Table 9-7. Under the present dam operation rule of the Kenering and Chenderoh dams, the annual average flood damage value is estimated at RM 2.6 million. When the RBIS is induced and Kenering and Chenderoh dams are used for flood control as described above, the annual average flood damage value is reduced to RM 2.0 million. The reduction of RM 0.6 million is regarded as the annual average economic benefit of the RBIS.

Thus, the annual flood damage value could be estimated systematically through the map information on land use map and the flood inundation extent. The map information could be renewed periodically, so that the annual flood damage could be updated and used as the basic data for projection of future flood mitigation schemes.

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TABLE

Table 2-1 LAND USE CONDITIONS IN PERAK RIVER BASIN (AS OF 1980 AND 1990)

Classification of Land Use	Area in 1980		Area in 1990	
	(ha)	(%)	(ha)	(%)
1 Settlement and Associated Non-Agriculture Lands	**889**	**5.86**	**821**	**5.41**
1 - 1 Urban and Associated Area			187	1.23
1 - 2 Estate Building and Associated Areas			4	0.03
1 - 3 Tin Mining Areas			601	3.96
1 - 4 Power Line Right of Ways			29	0.19
2 Agricultural Area (Non-Paddy Area)	**2,916**	**19.21**	**3,642**	**23.99**
2 - 1 Horticulture			319	2.10
2 - 2 Rubber			1,944	12.81
2 - 3 Palm			1,100	7.24
2 - 4 Others			279	1.84
3 Paddy Area	**145**	**0.96**	**271**	**1.79**
4 Forest Lands	**10,320**	**67.98**	**9,490**	**62.52**
4 - 1 Forest			8,953	58.98
4 - 2 Scrub Forest			344	2.27
4 - 3 Recently Cleared Land			32	0.21
4 - 4 Grass Land			159	1.05
4 - 5 Pasture			1	0.01
5 Swamps, Marshlands and Wetland Forests	**910**	**5.99**	**661**	**4.36**
5 - 1 Wetland and Associated Forest			486	3.20
5 - 2 Unused Land			175	1.15
6 Non-classified			**295**	**2.99**
TOTAL	**15,180**	**100**	**15,180**	**100**

Source : Land use map prepared by DOA in 1990 and National Water Resources Study in 1982 by JICA

Table 4-1 FEATURES OF EXISTING FLOOD MITIGATION WORKS

River System	Name of Scheme	Type of Work	Design Flood Level (Return Period)	Stretch	Year of Completion
Perak	Tran-Perak Stage IV Embankment	Perimeter Bund	25-year *	66km from Kubang Haji to Kg. Bakong	1976
	Lambor Kiri	Perimeter Bund	25-year *	5km from Kg. Bakong to Telok Sena	
	Stage I Drain Embankment	Perimeter Bund	25-year *	22km from Telok Sena to Kayan River	
Kinta	Ipoh Flood Mitigation Scheme	Dredging and Embankment of River Channel	25-year	6km Downstream of Anderson Road Bridge	Early of 1930's
	Kinta Conservancy Scheme	Alignment, Dredging and Embankment	10 to 100-year**	34km 5.3km downstream of Pari River confluence to Cenderiang confluence	1971
	Malaysia Mining Company Kinat Diversion	Alignment, Dredging and Embankment	5-year	8km (Downstream from confluence of Cenderiang River)	1980
	Pari Scheme	Channel Improvement	50-year	8km Pari River from confluence with Kinta river	1992

* Observed flood level in 1964 is adopted as the design High Water Level, and 0.2ft (0.6m) of freeboard is added on the HWL

** 100-year for 7km section upstream for confluence of Raja River
50-year for 11km section between confluence of Raja and Teja Rivers
10-year for 16km between confluence of Teja and Cenderiang Rivers

Table 4-2 PROPOSED FLOOD MITIGATION SCHEME

River System	Name of Scheme	Type of Works	Design Flood Level (return period)	Stretch	Remarks
Perak	Perak Flood Bypass Scheme	Combination of Channel Improvement and Flood Bypass Channel	100-year	66km from Kg. Bakong on Perak River to Kayan River (Flood Bypass)	1000m3/s as flow capacity for improved river and 950 m3/s for flood bypass channel
Kinta	Lower Kinta Diversion	Combination of Diversion Channel and Construction of Bund	25-year	1.5km from confluence with Tumboh River to confluence with Kroh River	Proposed by Tumboh Block Integrated Agricultural Development Project
	Sg. Kinta Upgrading	Channel Improvement	100-year	7.4km form Tasek Road Bridge to Anderson Bridge	
	Bund Upgrading (1)	Combination of Improvement of Bound and Bund Spillway	100-year	20km of bund improvement from Anderson Bridge to Batu Gaja	Overspill of on east bank of 8.7km in length (downstream from Old Pengklan Bridge, and on west bank of 14km in length
	Bund Upgrading (2)	Combination of Improvement of Bund and Bund Spillway	25-year	15km of bund improvement from Batu Gajah to confluence with Cenderiang	Supported by overspill bund by Raja Flood-Way, Kampar Floodway and Lower Kinta Floodway

Table 4-3 PRESENT MAP INFORMATION

Agency/Department		Ministry	Type of Map	Scale	Projection	Coverage	Data Source	Digitizing Status	GIS Status
DOA	Federal	MOA	Land Use Map	1:50,000	RSO	Whole Malaysia	Aerial photo, Ground truth, Satellite image for renewal	Completed	Exist (ARC/INFO)
			Reconnaissance Soil Map	1:500,000	RSO	P. Malaysia	Aerial photo, Ground truth	Completed	
			Semi-Detail Soil Map	1:25,000	RSO	P. Malaysia	Aerial photo, Soil sampling	On-going	
Dept. of Wildlife and National Park	Federal	MOSTE	Forest Cover and Protected Areas Map	1:1,000,000	RSO	P. Malaysia	Land Use Map (MOA) Digital Chart of World (ESRI) Ground survey	Completed	Exist (pc ARC/INFO)
Forest Dept.	Federal	MOPI	Forest Inventory Map	1:250,000	RSO	P. Malaysia	Ground survey	On-going	Exist (ARC/INFO)
			Forest Reserve Area, Forest Compartments Map	1:50,000 (1:63,360)	RSO	P. Malaysia	Aerial photo, Ground truth	On-going	
Forest Dept., Perak	State	MOPI	Forest Reserve Area, Forest Compartments Map	1:50,000 (1:63,360)	RSO	State	Aerial photo, Ground truth	On-going	On-going
Dept. of Geological Survey	Federal	MOPI	Geological Map	1:500,000	RSO	P. Malaysia	Aerial photo, Ground truth	On-going	Exist (ARC/INFO)
			Geological Map	1:250,000	RSO	State			
DSMM	Federal	MLCD	Topographic Map	1:50,000	RSO	Whole Malaysia	Aerial photo	On-going	No exist (Mapping System)
				1:25,000	RSO	Whole Malaysia	Aerial photo	On-going	
				1:10,000	RSO	Major City	Aerial photo	On-going	
DSMP	State	MLCD	Cadastral Map	1:800	Cassini	State	Ground survey	On-going	Exist (ARC/INFO)
Dept. of Land, Perak	State	MLCD	Cadastral Map	1:800	Cassini	State	Cadastral Map (DSMP)	On-going	On-going (NaLIS)
Perak Water Board	State	MWORKS	Cadastral Map	1:800	Cassini	State	Cadastral Map (Dept. of Land)	Completed	No exist (CAD System)
Town and Country Planning Dept., Perak	State	MHLG	Structure Plan	Various	RSO	State	Topographic Map (DSMM)	No plan	No exist (Proposed)

Abbreviation:
DOA: Dept. of Agriculture
DSMM: Dept. of Survey and Mapping Malaysia
DSMP: Dept. of Survey and Mapping Perak
MOA: Ministry of Agriculture
MOSTE: Ministry of Science, Technology and Environment
MOPI: Ministry of Primary Industry
MLCD: Ministry of Land and Cooperative Development
MWORKS: Ministry of Works
MHLG: Ministry of Housing and Local Government
NaLIS: National Infrastructure for Land Information System

Table 5-1(1/2) PRESENT AND PROPOSED INFROMATION SYSTEM CONFIGURATION

Agency/Department	Purpose	Software			Hardware		Network	No. of Stuff
		OS	GIS/RS	DB/others	Computer	Peripheral		
DID, Coastal Div.	Coastal Information Management	Windows	ArcView ArcCAD		PC	Digitizer Plotter Scanner(A4)	LAN	less than 5
DID, Hydrology Div.	Hydrological Data Management	UNIX (Server)		Infomix	UNIX Server		LAN	less than 5
		UNIX (Client)	Arc/Info ArcView	TIDEDA	Workstation	Digitizer Plotter		
		Windows (Client)	ArcView	TIDEDA	PC	Digitizer		
DOA	Land Use and Soil Database Management	UNIX (Server)		ORACLE	UNIX Server	Disk Storage & Back up Device	LAN	GIS: Officer x 1 Senior Technician x 1 Technician x 2 Operator x 4 RS: Officer x 1 Technician x 4
		UNIX (Client)	Arc/Info		Workstation	Digitizer Plotter		
		UNIX (Client)	ERDAS		Workstation	CCT Drive		
Fishery Dept.	Fisheries Management	UNIX (Server)		ORACLE	UNIX Server	8 mm Tape Back Device	WAN	In HQ x 7
		UNIX (Client)		In-house Application				
MOA	AGROLINK Network Administration, Home Page Production	UNIX		Web Server ftp Server BC Server	UNIX Server	Back Device	Internet Intranet LAN	In HQ System Engineer x 3 (full time) Application Group x 12 (temporally)
		WindowsNT		Video Server Audio Server IPC Server news Server BC Server	WindowsNT Server	Back Device		
DOE	River Environment Management	UNIX	Arc/Info ERDAS		Workstation	Digitizer Plotter	LAN	less than 5
		Windows	ArcView		PC			

Table 5-1(2/2) PRESENT AND PROPOSED INFROMATION SYSTEM CONFIGURATION

Agency/Department	Purpose	Software			Hardware		Network	No. of Stuff
		OS	GIS/RS	DB/others	Computer	Peripheral		
Dept. of Wildlife and National Park	Protected Areas Map Production	UNIX	Arc/Info		Workstation	Digitizer Plotter		less than 5
MACRES	Consultant, Training and Contract Research	UNIX	Geovision SPANS		Workstation	Digitizer Plotter	LAN	All of Staff x 90
		Windows	Geovision SPANS		PC	Digitizer Plotter		
Forest Dept.	Forestry Information Management	UNIX (Server)	Arc/Info		UNIX Server	DAT Drive Plotter	LAN	GIS Expert x 2 Digitizing Operator x 6
		UNIX (Client)	Arc/Info		Workstation			
		UNIX (Client)	ERDAS		Workstation			
		MS-DOS	Arc/Info		PC	Digitizer		
		MS-DOS	ERDAS ArcView			CCT Drive Color Printer		
Mines Research Institute	Geological Survey	UNIX	Arc/Info		Workstation	Digitizer Plotter		less than 10
DSMM	Topographic Mapping	OpenVMS	Sysdeco GINIS (Mapping Software, Norway) ER Mapper		Minicomputer Workstation	Digitizer Scanner Plotter Film Writer Cell Plotter	LAN	Officer x 20 Technician x 80
DSMP	Cadastral Survey and Mapping	UNIX	Arc/Info		UNIX Server Workstation	Digitizer Plotter MO Drive	LAN	less than 10
Perak Water Authority	Water Supply Facility Management, Delivery Network Analysis	Windows	AutoCAD		PC	Digitizer Plotter		less than 10
Town and Country Planning Dept., Perak	Urban Development Plan	UNIX PC	GenaMap MapInfo		UNIX Server Workstation	Digitizer Plotter MO Drive	LAN	NA (Proposed)

Table 6-1 OBJECTIVE INFORMATION TO BE COLLECTED AND THE PRESENT COMPETENT AGENCY FOR INFORMATION

Objective Information					Present Competent Agency for the Information
Major Category	Detailed Category	Real-time information	Non-real time information	Digitization of non real time information	
1. River Gauging and Monitoring Information	1. Hydrological information (rainfall, river stage/discharge, river suspended sediment load and tidal level)	yes	yes	Completed	DID, TNB (Federal)
	2. Dam reservoir information (inflow/outflow discharge and reservoir level)	yes	yes		
	3. Water Quality information and location map of water sampling point	yes	yes	Completed	DOE (Federal)
	4. Inventory and location of pollutant source		yes		DOE (State)
	5. Visual information of the field	yes			
2. Information on River Works	1. Flood control works (i) Inventory/location of existing flood control structures (ii) Flood mitigation plan		yes		DID (state)
	2. Water supply works (i) Inventory/location of existing intake points (ii) Water intake volume of each facilities		yes		PWB and DID (State)
	3. River Environmental Improvement Works (i) Inventory/location of echo-tourism facilities controlled by Yayasan Perak (ii) Location of river side park managed by local authority		yes		Yayasan Perak and Local Authority (State)
	4. River Sand Mining (i) Inventory of permit holders for sand mining (including mining volume, mining method, etc.) (ii) Location of mining sites		yes		Department of Land and Mining (State)
	5. Bridge Construction (i) Inventory and structural features of bridges (ii) Location of bridges		yes		Public Work Department (Fedral)
3. Information on Field Survey	1. Results of river channel survey (river plans, longitudinal profiles, river cross-sections)		yes		DID (State)
	2. Results of flood damage survey		yes		DID (Federal and State)
	3. Results of survey on fauna and flora		yes	On-going	DOWLNP (Federal)
4. Basin Land Information (Map Information)	1. Land use map		yes	Completed	DOA (Federal)
	2. Forest conservation map and annual logging volume		yes	On-going	Forest Department (State)
	3. Topographic map		yes	On-going	DSMM (Federal)
	4. Cadastral (land parcel) map		yes	On-going	PWB (State)
	5. Soil map		yes	Completed	DOA (Federal)
	6. Structural Plan (urban development and industrial development)		yes		Town and Country Dep. (State)
5. Basin Census information	1. Population		yes		EPU and Dep. of Statistics (State)
	2. Socio-economic statistics		yes		EPU and Dep. of Statistics (State)

Table 6-2(1/3) OBJECTIVE INFORMATION TO BE DISSEMINATED AND DISSEMINATION LEVEL

Category of Management	Information to be Disseminated	Information Source (Major Category No.- Detailed Category No. in Table II-9)	Dissemination Level *
I. General	1. Features of River Basin		
	(1) Catchment area	4-3	Level 2
	(2) River system	4-3	Level 2
	(3) Length of river channel	4-3	Level 2
	(4) Socio-economic census in the basin	4-3, 5-2	Level 2
	2. Hydrological Information		
	(1) Inventory of gauging stations	1-1	Level 2
	(2) Location of gauging stations	1-1	Level 2
	(3) Rainfall data (hourly and daily)	1-1	Level 2
	(4) River stage data (mean daily, max. and min.)	1-1	Level 2
	(5) River discharge data (rating curve, mean daily, max. and min.)	1-1	Level 2
	(6) River suspended discharge (rating curve, mean daily, max. and min.)	1-1	Level 2
	3. River Structures (Bridges, Water Pipes, etc.)	2-5	
	4. Map Information		
	(1) Topographic map	4-3	Level 1
	(2) Soil map	4-5	Level 1
II. Flood Management	1. Real-time Flood Gauging and Monitoring Information		
	(1) Flood hydrological gauging information	1-1	Level 2
	(2) Dam reservoir gauging information	1-2	Level 2
	(3) Visual information of flood condition in the field	1-5	Level 2
	2. Existing and Projected Flood Mitigation Schemes		
	(1) Present channel flow capacity	3-1	Level 2
	(2) Design flood	2-1	Level 2
	(3) Structural features of facilities (dike, floodway, etc.)	2-1	Level 2
	(4) Location of facilities	2-1	Level 2
	3. Flood Inundation Area		
	(1) Probable basin run-off discharge	1-1	Level 1
	(2) Extent of probable flood inundation area (PFIA)	3-1, 4-3	Level 1
	(3) Socio-economic census in PFIA	5-1, 5-2	Level 1
	(4) Present land use in PFIA	4-1	Level 1
	(5) Structural Plan in PFIA	4-6	Level 1
	4. Flood Damage Record		
	(1) Hydrological conditions	3-2	Level 2
	(2) Extent of flood inundation area	3-2	Level 2
	(3) Road length inundated	3-2	Level 2
	(4) Number of people affected	3-2	Level 2
	(5) Flood damage amount	3-2	Level 2
	(6) Epidemic caused by flood	3-2	Level 2

* : Level 1 disseminates to the government agencies only, while Level 2 opens to the public.

Table 6-2(2/3) OBJECTIVE INFORMATION TO BE DISSEMINATED AND DISSEMINATION LEVEL

Category of Management	Information to be Disseminated	Information Source (Major Category No.- Detailed Category No. in Table II-9)	Dissemination Level *
III. Water Supply and Water Resources Management	1. Real-time Low Flow Gauging Information		
	(1) Low flow discharge gauging information	1-1	Level 2
	(2) Dam reservoir gauging information during a drought period	1-2	Level 2
	(3) Water quality gauging information	1-3	Level 2
	2. Existing and Projected Intake Facilities		
	(1) Inventory of facilities	2-2	Level 2
	(2) Location of facilities	2-2	Level 2
	(3) Design intake capacity	2-2	Level 2
	(4) Structural features	2-2	Level 2
	3. Existing and Projected Water Resources Development Facilities		
	(1) Inventory of facilities	2-2	Level 2
	(2) Location of facilities	2-2	Level 2
	(3) Structural features of facilities	2-2	Level 2
	(4) River maintenance discharge guaranteed by facilities	2-2	Level 2
	4. Irrigation Water Supply		
	(1) Monthly irrigation demand	2-2	Level 2
	(2) Extent and location of irrigation area	2-2	Level 2
	5. Domestic/industrial water supply		
	(1) Daily water demand	2-2	Level 2
	(2) Service area of public water supply	2-2	Level 2
	(3) Number of people to be supplied	2-2	Level 2
IV. Environmental Management	1. Real-time Water Quality Gauging Information	1-3	Level 2
	2. Channel Morphology		
	(1) River stretch of serious sedimentation	3-1	Level 2
	(2) River Stretch of serious erosion	3-1	Level 2
	(3) River stretch of serious meandering	3-1	Level 2
	3. Sand Mining		
	(1) Location of mining sites	2-4	Level 2
	(2) Annual mining volume	2-4	Level 2
	(3) List of permit holders	2-4	Level 2
	4. Water Quality		
	(1) Identified pollutant sources	1-3	Level 2
	(2) Results of water quality tests	1-2	Level 2
	5. Fauna and Flora in the River		
	(1) Results of field survey (sex, size, location and habit)	3-3	Level 2
	6. Echo-tourism		
	(1) Tourism-boat service (route, date for boating, fee, application method, etc.)	2-3	Level 2
	(2) Tourism spots along river (historical monuments, river parks, camping sites, etc.)	2-3	Level 2
	(3) Lodging facilities	2-3	Level 2

* : Level 1 disseminates to the government agencies only, while Level 2 opens to the public.

Table 6-2(3/3) OBJECTIVE INFORMATION TO BE DISSEMINATED AND DISSEMINATION LEVEL

Category of Management	Information to be Disseminated	Information Source (Major Category No.- Detailed Category No. in Table II-9)	Dissemination Level *
V. Watershed Management	1. Logging Activities		
	(1) Classification of forest reserve area	4-2	Level 1
	(2) Annual logging volume	4-2	Level 1
	2. Present Land Use		
	(1) Land use map	4-1	Level 2
	(2) Existing major urban areas	4-1	Level 2
	(3) Existing major industrial estates	4-1	Level 2
	3. Structural Plans		
	(1) Overview map of structural plan	4-6	Level 1
	(2) Projected urban development areas (location, extent, target year, etc.)	4-6	Level 1
	(3) Projected industrial estates (location, extent, target year, etc.)	4-6	Level 1
	4. Cadastral Map	4-4	Level 1

* : Level 1 disseminates to the government agencies only, while Level 2 opens to the public.

Table 6-3 MAJOR SYSTEM DEVICES PROPOSED IN MASTER PLAN

Category	Device
Gauging and Monitoring	Radar rainfall (1 station)
	Telemetry point rainfall gauge (8 stations)
	Telemetry river stage gauge (16 stations)
	Automatic water quality sensor (5 stations)
	Manual water quality sampling (53 points)
	ITV (for monitoring of dynamic scenes of the field) (10 sets)
	PIT (for monitoring of static scenes of the field) (1 set)
Data Input and Processing	Scanner supported by the software of raster/vector transformation (2sets)
	Optical character reader (OCR) (2 sets)
	Server machine for river basin management (UNIX) (4 units)
	Server machine for telemetry data management (UNIX) (4 units)
	Server machine for communication control (UNIX) (4 units)
	Computer for analysis of radar rainfall and water quality automatically monitored (2 units)
Data Dissemination	Audio machine to play the visual scenes of the field (1 unit)
	Internet
	CD-ROM
Data Transmission	Optical fiber network (for trunk line and communication with ITV)
	Satellite communication network (for buck-up communication)
	Telemetry communication network (for transmission of gauge data)
	Public telephone network (for Internet communication)

Table 6-4 INVESTMENT COST FOR RIVER BASIN INFORMATION SYSTEM PROPOSED IN MASTER PLAN

Devices	Unit Cost ('000 RM)	Quantity	Cost ('000RM)	%
1. Gauging/monitorind				
Radar rainfall gauge	4,230 /unit	1 unit	4,230	21.6
Real-time water quality gauge	160 /unit	5 units	800	4.1
Industrial television (ITV)	247 /unit	4 units	987	5.0
Portable information terminal (PIT)	7 /unit	1 unit	7	0.0
Sub-total			6,025	30.8
2. Data processing				
Setver machine (UNIX)	76 /unit	9 units	684	3.5
Computer for radar analysis	6,840 /unit	1 unit	6,840	35.0
Computer for water quality analisis	1,100 /unit	1 unit	1,100	5.6
Input device	126 /unit	2 units	252	1.3
Output device	32 /unit	1 unit	32	0.2
Terminal Adopter	6 /unit	2 units	12	0.1
Software	Lamp sum		705	3.6
Audio Machines	828 /unit	2 units	1,656	8.5
Sub-total			11,281	57.7
3. Data Transmission				
Maltiplex radio wave for rainfall radar	1,320 /unit	1 unit	1,320	6.7
Telemetry divice for water quality	90 /unit	5 units	450	2.3
Telemetry line for water level gauge	60 /unit	8 units	480	2.5
Sub-total			2,250	11.5
Grand Total			19,556	100

Table 6-5 QUALITATIVE IMPROVEMENT OF INFORMATION BY THE PROPOSED SYSTEM

Item of Information	Qualitative Improvement
1. Gauging data	(1) Rainfall gauging area is expanded by radar rainfall gauge covering the present blind area particularly in the upper reaches. (2) Gauging of water quality and river flow discharge is unified at the principal gauging points. (3) The dynamic visual and audible scenes of remote field could be monitored by the ITV system.
2. Information related to flood management	(1) Location and structure of previous and on-going flood mitigation works in the entire river basin are made available. (2) The river channel flow capacity of the entire river stretch is newly made available. (3) Extent of probable flood inundation area as well as land use and other socio-economic statistics in the possible flood inundation area are newly made available.
3. Information related to water supply and water resources management	(1) Location and structural features of all water supply and water resource facilities in the river basin are newly made available. (2) All water intake volume for the entire river basin system are integrated into a unified data base (3) All water demands with Perak river as the source are integrated into a unified data base. (4) Perspective of all water intake volume and the river flow discharge are monitored on the real-time base.
4. Information related to environmental management	(1) Information of river morphology (the river channel survey) are newly made available. (2) Integrated information on the ecotourism are newly made available. (3) Inventory of fauna and flora in Perak river are newly made available.
5. Map information	(1) The following map information for the entire Perak river basin are newly made available; (a) Classification of forest reserve area (b) Updated land use map (c) Structural Plan (urban and industrial development plan (d) Cadastral map

Table 6-6 ANNUAL EXPENDITURES FOR RIVER DEVELOPMENT PLANS BY STATE DID OF PERAK

Year	Expenditure (RM million)	Man-month of Required Stuffs			
		Professional Engineer	Assistant Engineer	Technician	Total
1991	0.82	30	61	121	212
1992	0.88	33	65	130	228
1993	0.95	35	70	140	246
1994	N/A	N/A	N/A	N/A	N/A
1995	1.15	42	85	169	297
1996	1.12	41	83	166	290
1997	1.39	51	102	205	359

Note: The expenditure is solely for study and/or plan formulation excluding the construction cost.

Table 6-7 CASH FLOW OF ECONOMIC COST AND BENEFIT OF RIVER BASIN INFORMATION SYSTEM PROPOSED IN MASTER PLAN

(Unit: RM million)

Year	(1) Investment Cost	(2) Accumulated Investment Cost	(3) Maintenance Cost *	(4) Total Cost (1)+(3)	(5) Full Benefit	(6) Actual Benefit	(7) (1)-(6)	Remarks
2001	0.390	0.39	0.37	0.76	0.84	0.02	0.75	8th Malaysia Plan
2002	0.393	0.78	0.44	0.83	0.95	0.04	0.79	- ditto-
2003	0.396	1.18	0.51	0.91	1.09	0.07	0.83	- ditto-
2004	0.399	1.58	0.58	0.98	1.24	0.11	0.87	- ditto-
2005	0.403	1.98	0.65	1.05	1.41	0.16	0.89	- ditto-
2006	0.409	2.39	0.72	1.13	1.60	0.22	0.91	9th Malaysia Plan
2007	0.415	2.80	0.79	1.21	1.82	0.29	0.92	- ditto-
2008	0.421	3.23	0.87	1.29	2.07	0.38	0.91	- ditto-
2009	0.427	3.65	0.94	1.37	2.36	0.49	0.88	- ditto-
2010	0.434	4.09	1.02	1.45	2.68	0.62	0.83	- ditto-
2011	0.697	4.78	1.14	1.83	3.05	0.83	1.00	10th Malaysia Plan
2012	1.120	5.90	1.33	2.45	3.48	1.16	1.29	- ditto-
2013	1.800	7.70	1.64	3.44	3.96	1.73	1.71	- ditto-
2014	2.893	10.60	2.14	5.04	4.50	2.71	2.33	- ditto-
2015	4.649	15.25	2.95	7.60	5.12	4.43	3.17	- ditto-
2016	1.581	16.83	3.41	4.99	5.83	5.56	-0.58	11th Malaysia Plan
2017	0.537	17.36	3.50	4.04	6.63	6.53	-2.50	- ditto-
2018	0.183	17.55	3.53	3.71	7.55	7.51	-3.80	- ditto-
2019	0.062	17.61	3.54	3.60	8.59	8.58	-4.98	- ditto-
2020	0.021	17.63	3.54	3.57	9.78	9.78	-6.21	Project Completed
2021			3.54	3.54	9.78	9.78	-6.23	
2022			3.54	3.54	9.78	9.78	-6.23	
2023			3.54	3.54	9.78	9.78	-6.23	
2024			3.54	3.54	9.78	9.78	-6.23	
2025			3.54	3.54	9.78	9.78	-6.23	
2026			3.54	3.54	9.78	9.78	-6.23	
2027			3.54	3.54	9.78	9.78	-6.23	
2028			3.54	3.54	9.78	9.78	-6.23	
2029			3.54	3.54	9.78	9.78	-6.23	
2030			3.54	3.54	9.78	9.78	-6.23	
Total	17.63	153.28	69.06	86.69	172.33	149.01		
						EIRR=	10.8%	

Note :
Maintenance Cost includes the followings

(1) Maintenance cost of equipment (=15% of the accumulated economic investment cost)
(2) Man-power cost for system operation
(= The financial cost (RM 0.46 million) x economic conversion factor (0.9)) x (Accumulated investment cost) / (total investment cost)
(3) Lease cost of optical fiber system (=The financial lease cost (RM 0.34 million) x economic conversion factor (0.9))
(4) Lease cost of satellite communication system (The financial lease cost (RM 0.2 million) x economic conversion factor (0.9))
only during 11th Malaysia Plan

Table 7-1(1/5) OBJECTIVE INFORMATION TO BE DISSEMINATED (MAP INFORMATION)

Category	Name of Map and Scale of Original Map	Contents in the Map			Renewal Interval of Information	Agency as Data Source	Dissemination Level*
		Name of Data	Type of Data	Attribute			
General Information	1 Base Map (Scale: 1/500,000)	1.1.1 Basin Boundary	Polygon	Name of sub-basin	As required	DSMM	Level 2
		1.1.2 River Line	Line	Name of river			
		1.1.3 District Boundary	Polygon	Extent of sub-basin			
		1.1.4 Major Road	Line	Name of road			
		1.1.5 Major Town	Point	Name of town			
		1.1.6 Major Bridge	Point	Name of bridge Organization to maintain Structural features			
Hydrological Information	2 Location Map of Gauging Point (Scale: 1/500,000)	2.1.1 Gauging Point	Point	Name of station Type of station Gauging period Current equipment Catchment area (for water level St.) Gauging data	As required	DID and MMS	Level 2
Information on Flood Mitigation	3 Location Map of Flood Mitigation Scheme (Scale: 1/500,000)	3.1.1 Stretch of channel works	Line	Name of scheme Type of work Design flood level Competent agency	As required	DID	Level 2
		3.1.2 Dam and Other Flood Mitigation Structure	Point	Completion year Name of scheme Type of work Design flood level Competent agency	As required	DID and TNB	Level
	3 Flood Inundation Area (Scale: 1/500,000)	3.2.1 Flood Inundation Area	Polygon	Flood Scale (recurrence probability)	Annually	DID	Level 1
		3.2.2 Major Town Area	Polygon	Name of town			
		3.2.3 Mukim Boundary	Polygon	Name of Mukim			
Information on Water Supply Management	4 Location Map of Intake Point (Scale: 1/500,000)	4.1.1 Intake Point	Point	Name of intake facility Purpose of intake Structural type of intake Intake capacity Monthly average intake discharge Name of supply area Extent of supply area (ha)	Annually	PWB and DID	Level 2
		4.1.2 Irrigation Scheme	Polygon	Name of irrigation scheme Name of intake point Intake capacity Clopping schedule Monthly average intake discharge	Annually	DID	Level 2
		4.1.3 Domestic and Industrial Supply Area	Polygon	Name of service area Name of intake point Intake capacity Daily average water demand	Annually	PWB	Level 2

*: Level1 disseminates to the government agency only, while Level 2 opens to Public

Table 7-1(2/5) OBJECTIVE INFORMATION TO BE DISSEMINATED
(MAP INFORMATION)

Category	Name of Map and Scale of Original Map	Contents in the Map			Renewal Interval of Information	Agency as Data Source	Dissemination Level*
		Name of Data	Type of Data	Attribute			
Information on River Environmental Management	5.1 Location Map of River Water Quality Sampling Station (Scale: 1/500,000)	5.1.1 Sampling Station	Point	Name of sampling station	Annually	DOE	Level 2
	5.2 Location Map of Major Pollutant Sources (Scale: 1/500,000)	5.2.1 Major Pollutant Sources	Point	Type of industry Code of pollutant sources	Annually	DOE	Level 1
	6.1 Location Map of Protected Area (Scale: 1/500,000)	6.1.1 Protected Area	Polygon	Name of Protected Area Extent of protected area (ha)	Once/ 3 years	DWNP	Level 2
	7.1 Location Map of River Parks (Scale: 1/500,000)	7.1.1 River Parks	Point	Name of River Parks	Annually	LOCAL AUTHORITY	Level 2
	7.2 Location Map of Camp Sites (Scale: 1/500,000)	7.2.1 Camp Sites	Point	Name of Camp Sites	Annually	Yayasan Perak	Level 2
	7.3 Location Map of Royal Mausoleums (Scale: 1/500,000)	7.3.1 Royal Mausoleums	Point	Name of Royal Mausoleums	Annually	Yayasan Perak	Level 2
Information on Watershed Management	8.1 Geological Map (Scale: 1/500,000)	8.1.1 Geological Classification	Polygon Line	Name of class Fault	Non	DGSM	Level 2
	9.1 Reconnaissance Soil Map (Scale: 1/500,000)	9.1.1 Soil Classification	Polygon	Name of class	5 year (Only Urban Area)	DOA	Level 2
	10 Land Use Map (Scale: 1/50,000)	10.1.1 Land Use Classification	Raster	Name of Class	5 year in Principle	DOA	Level 2
			Polygon	Name of Class			Level 1
	11 Structure Plan (Scale : Variable)	11.1.1 Development Corridors	Raster	Name of Corridor	Target Year : 2020	TCPD	Level 2
		11.1.2 Future Land Use	Polygon	Name of Class			Level 1
		11.1.3 Major Projects	Point	Explanation Table			
	12 Forest Reserve Map (Scale: 1/50,000)	12.1.1 Forest Reserve and Protection Forest	Raster	Name of Protection Forest	Non	FD	Level 2
			Polygon	Name of Forest Reserve			Level 1
			Point	Name of Protection Forest and Area			
	13 Cadastral Map (Scale : 1/790)	13.1.1 Land Parcel Boundary 13.1.2 Land Parcel No.	Line Point	- Land Registration	Occasion at Need	DOLM, PWB	Level 1

*: Level1 disseminates to the government agency only, while Level 2 opens to Public

Table 7-1(3/5) OBJECTIVE INFORMATION TO BE DISSEMINATED
(TABULAR INFORMATION)

Category	Name of Table	Renewal Interval of Information	Agency as Data Source	Dissemination Level*
Hydrological Information	1.1 Inventory of gauging station	Annually	DID	Level 2
	1.2 Hourly rainfall in northeast monsoon period (Oct. - Jan.)**	Annually & Real-time	DID	Level 2
	1.3 Daily and monthly rainfall	Annually	DID	Level 2
	1.4 Annual maximum rainfall	Annually	DID	Level 2
	1.5 Hourly river stage/discharge in northeast monsoon period(Oct. - Jan.)**	Annually & Real-time	DID	Level 2
	1.6 Daily and monthly river stage/discharge	Annually	DID	Level 2
	1.7 Annual maximum and minimum river stage/discharge	Annually	DID	Level 2
	1.8 Discharge rating table	Annually	DID	Level 2
	1.9 Monthly suspended sediment	Annually	DID	Level 2
	1.10 Annual maximum and minimum suspended sediment	Annually	DID	Level 2
	1.11 Sediment rating table	Annually	DID	Level 2
	1.12 Hourly and/or daily dam outflow discharge	Real-time	TNB	Level 2
	1.13 Monthly meteorological information	Annually	MMS (statistical book)	Level 2
	1.14 Tidal levels	Annually	Royal Malaysian Navy	Level 2
Information on Flood Mitigation	2.1 Inventory of Existing Flood Mitigation Scheme	As required	DID	Level 2
	2.2 Inventory of Projected Flood Mitigation Scheme	As required	DID	Level 2
	2.3 Probable Flood Peak Discharge	As required	DID	Level 2
	2.4 Longitudinal Profile of River Channel and Probable Flood Level	As required	DID	Level 2
	2.5 River Channel Flow Capacity	As required	DID	Level 2
	2.6 Flood Damage Record	Annually	DID	Level 2
Information on Water Supply Management	3.1 Inventory of Intake Facility		PWB and DID	Level 2
	3.2 Inventory of Irrigation Scheme		DID	Level 2
	3.3 Inventory of Domestic and Industrial Water Supply		PWB	Level 2
	3.4 Monthly Water Demand		PWB and DID	Level 2

*: Level1 disseminates to the government agency only, while Level 2 opens to Public
**: Include the real-time information

Table 7-1(4/5) OBJECTIVE INFORMATION TO BE DISSEMINATED
(TABULAR INFORMATION)

Category	Name of Table	Renewal Interval of Information	Agency as Data Source	Dissemination Level*
Information on River Environmental Management	4.1 Inventory of River Water Quality Sampling Station	Once a year	DOE	Level 2
	4.2 Inventory of Pollutant Sources	Once a year	DOE	Level 1
	4.3 River Water Quality Results on human life	3 times a year	DOE	Level 2
	4.4 River Water Quality Results on other items	3 times a year	DOE	Level 2
	4.5 Effluent Water Quality & Discharge survey data	3 times a year	DOE	Level 2
	4.6 General Rating Scale for WQI	Database	DOE	Level 2
	4.7 Effluent Water Quality Standards	Database	DOE	Level 2
Information on Watershed Management	5.1 Major Projects (Development Category, Name, Owner, Location, Area, Cost)	Target Year : 2020	TCPD	Level 1
	6.1 Forest Compartment Relational Table	Non	FD	Level 1
	6.2 Forest Management Record Table	Yearly		
	6.3 Logging Volume (Computation Result)	-		
	7.1 Land Registration Table	Occasion at Need	DOLM	Level 1

*: Level1 disseminates to the government agency only, while Level 2 opens to Public

Table 7-1(5/5) OBJECTIVE INFORMATION TO BE DISSEMINATED
(GRAPHIC INFORMATION)

Category	Name of Graph	Renewal Interval of Information	Agency as Data Source	Dissemination Level*
Hydrological Information	1.1 Rainfall intensity curve at Ipoh	-	DID	Level 2
	1.2 Mean monthly rainfalls at sub-regions	-	DID	Level 2
Information on Flood Mitigation	2.1 Longitudinal channel profile and probable water level		DID	Level 2
	2.2 Profile of river channel flow capacity		DID	Level 2
Information on River Environmental Management	3.1 Water Quality Results of each sampling point	Once a year	DOE	Level 2
	3.2 Effluent Load of Major Pollutant Sources	Once a year	DOE	Level 1
	3.3 Longitudinal Variation of River Water Quality	Once a year	DOE	Level 2
	3.4 Annual Trend of Water Quality at Class 1 point (3 points)	Once a year	DOE	Level 2
	4.1 Distribution of Aquatic Wildlife	Once per 3 years	DWNP	Level 2
Information on Watershed Management	5.1 Historical Logging Volume	1 Year	FD	Level 1

*: Level1 disseminates to the government agency only, while Level 2 opens to Public

Table 7-2(1/2) INVENTORY OF ALL HARDWARE AND SOFTWARE IN OPERATIONAL SYSTEM

Hardware Name	Function	Specification	Location
HP C200 UNIX WORKSTATION	• GIS Database Server • GIS Private Web Server • GIS Global Web Server • Internet Map Server	• RISC CPU: 200 MHz • Memory: 128 MB • Hard Disk: 9 GB • Two Network Cards	DID HQ in KL
HP C200 UNIX WORKSTATION	• TM Data Server • TM Private Web Server • TM Global Web Server	• RISC CPU: 200 MHz • Memory: 128 MB • Hard Disk: 8 GB • Two Network Cards	DID HQ in KL
HP Kayak XA Pentium II Personal Computer	• GIS Database Creation Machine • CD-R Backup Machine	• Intel Pentium II 233 MHz CPU • 64 MB Memory • 2.5 GB Hard disk	DID HQ in KL
HP Vectra VL 6 Pentium II Personal Computer	• Real-time Data Transmission Machine	• Intel Pentium II 233 MHz CPU • 64 MB Memory • 2.5 GB Hard disk	DID PERAK in IPOH
Calcomp Drawing Board III Digitizer Model34480	• GIS Graphic Data Input	• A0 Size Tablet • 16 Button Cordless Courser	DID HQ in KL
HP DesignJet 750C Plotter	• Map Output Device	• A0 Size Paper • Color Ink Jet	DID HQ in KL
HP LaserJet 6MP Printer	• Document Output Device	• A4 Size Paper • Post Scrip	DID HQ in KL
HP LaserJet 6MP Printer	• Document Output Device	• A4 Size Paper • Post Scrip	DID PERAK in IPOH
3COM Superstack II PS HUB 40 TP	• Private Net Connect HUB in KL	• 12 Ports • 100 MB • Optical Fiber Transceiver	DID HQ in KL
3COM Superstack II PS HUB 40 TP	• Global Net Connect HUB in KL	• 12 Ports • 100 MB	DID HQ in KL
3COM Office Connect HUB	• Private Net Connect HUB in IPOH	• 8 Ports • 10 MB	DID PERAK in IPOH
Cisco 2503 Router	• ISDN Link in KL	• 128 kbps ISDN Line Modem	Agrolink in KL
Cisco 2503 Router	• ISDN Link in IPH	• 128 kbps ISDN Line Modem	DID PERAK in IPOH

Table 7-2(2/2) INVENTORY OF ALL HARDWARE AND SOFTWARE IN OPERATIONAL SYSTEM

Hardware Name	Function	Specification	Location
HP SureStore DAT	• Server Backup Driver	• 4mm Tape	DID HQ in KL
Yamaha CDR400tx	• CD Recorder for Distributing Data	• 4X Write / 6X Read	DID HQ in KL
PK 600 AVR	• To save unstable power supply for Digitizer	• 600 VA	DID HQ in KL
PK 600 AVR	• To save unstable power supply for PC and Printer	• 600 VA	DID HQ in KL
PK 1052C/CX UPS	• Back up power for the GIS server computer	• 4 hours full load	DID HQ in KL
PK 1052C/CX UPS	• Back up power for the TM server computer	• 4 hours full load	DID HQ in KL
PK 1052C/CX UPS	• Back up power for the Real-time system in IPOH	• 4 hours full load	DID PERAK in IPOH
3COM Ethernet Card	• Upgrading exist TeleWin PC in IPOH	• 10/100 BaseT	DID PERAK in IPOH
Arc Info	• GIS Database Management • GIS Analysis tools	• Full Option • Version 7.1.2	DID HQ in KL
Arc View PC	• GIS Database Input Tool	• Version 3	DID HQ in KL
Arc View IMS	• GIS Information Distribution Tool	• Version 1	DID HQ in KL
Netscape Suitespot	• Web Server Software for GIS Server	• Version 3.1	DID HQ in KL
Netscape Suitespot	• Web Server Software for TM Server	• Version 3.1	DID HQ in KL
HP JetDirect Printer Server	• Unix Printer Utilities Software	• Full Version	DID HQ in KL

Table 7-3 PROCUREMENT COST OF HARDWARE AND SOFTWARE FOR THE OPERATIONAL SYSTEM

Item	Quantities	Unit Cost RM	Cost RM
1. Hardware			
(1) Workstation	2 units	111,490	222,980
(2) Personal Computer	2 units	10,980	21,960
(3) Digitizer	1 unit	15,480	15,480
(4) Plotter	1 unit	23,300	23,300
(5) Laser Jet Printer	2 units	3,760	7,520
(6) HUB(10Mb)	2 units	690	1,380
(7) HUB(100Mb)	1 unit	2,940	2,940
(8) Modular Router	2 units	11,700	23,400
(9) 4 mm Type Driver	1 unit	4,930	4,930
(10) CD-R Driver	1 unit	2.650	2,650
(11) AVR	2 units	260	520
(12) UPS	3 units	4,980	14,940
(13) Ethernet Cable	16 units	50	800
(14) Power Supply Cable	3 meters x 3	25	75
(15) Power Supply Cable	5 meters x 3	40	120
(16) Ethernet Card	1 unit	440	440
(17) Consumption	Plotter Ink x 5 sets	690	
(18) Consumption	Plotter Paper x 5 sets	245	
(19) Consumption	CD-R disc x 20 pices	20	
(20) Consumption	Printer toner x 2 set	380	
(21) Consumption	DAT/DDS Type x 1 set	340	
Sub-total			347,660
2. Software			
(1) Arc/Info	1	350,310	350,310
(2) Arc/View	1	36,110	36,110
(3) Web Server Soft	2	33,000	66,000
(4) Printer Server Soft	2	480	960
(5) Installation	1	15,000	15,000
Sub-total			468,380
Grand Total			816,040

Table 7-4 COST FOR DEVELOPMENT OF APPLICATION PROGRAM FOR TELEMETRY SYSTEM UNDER THE OPERATIONAL SYSTEM

Description	Unit Cost (RM)	Cost (RM)
1. Data Transmission Application: a. Reprogramming Telewin to enable: • Manual key-in dam data. • Calculating all station's discharge data. • Alarm generation. • Data feeding. b. Installation, Testing and Commissioning. c. Creation of manual.	42,000	42,000
2. Web Server Communication: a. To write data transfer scheduler program. b. Installation, Testing and Commissioning. c. Creation of manual.	25,200	25,200
3. Web Viewer Application: a. Web-page design with generation and web server data integration and application. b. Installation, Testing and Commissioning. c. Creation of manual.	66,920	66,920
Total		134,120

Table 7-5 COST FOR INITIAL DATA INPUT TO THE OPERATIONAL SYSTEM (1/2)

Description	Quantities	Unit Cost (RM)	Cost (RM)
1. Digitizing and Data Import of Map Information			
(1) Basin Boundary	28 sheets	2,400	66,900
(2) Contour	28 sheets	5,500	153,400
(3) River	28 sheets	5,500	153,400
(4) District Boundary	28 sheets	3,400	94,400
(5) Major Road and Railway	28 sheets	2,800	78,700
(6) Major Town	13 sheets	2,800	36,500
(7) Major Bridge	9 sheets	2,400	21,500
(8) Real-time Gauging Station	12 sheets	2,400	28,700
(9) Non-real time Gauging Station	23 sheets	2,400	54,900
(10) Mean Monthly Rainfall	5 sheets	2,800	14,100
(11) Location of Channel Stretch	10 sheets	2,800	28,100
(12) Flood Mitigation Scheme	10 sheets	2,400	23,900
(13) Flood Inundation Area	6 sheets	3,100	18,500
(14) Intake Point	2 sheets	2,400	4,800
(15) Domestic/Industrial Supply Area	2 sheets	3,100	6,200
(16) Water Quality Sampling Points	2 sheets	2,400	4,800
(17) Major Pollutant Sources	2 sheets	2,400	4,800
(18) Protected Area	2 sheets	2,400	4,800
(19) Distribution of Aquatic Wildlife	2 sheets	2,400	4,800
(20) River Parks	9 sheets	2,400	21,500
(21) Camp Sites	9 sheets	2,400	21,500
(22) Royal Mausoleums	9 sheets	2,400	21,500
(23) Geology	2 sheets	5,500	11,000
(24) Soil	2 sheets	3,200	6,500
(25) Land Use	2 sheets	3,200	6,500
(26) Structure Plan	1 sheets	3,200	3,200
(27) Future Land Use Plan	1 sheets	3,200	3,200
(28) Forest Reserve	2 sheets	3,200	6,500
Sub-total			904,600

Table 7-5 COST FOR INITIAL DATA INPUT TO THE OPERATIONAL SYSTEM (2/2)

Description	Quantities	Unit Cost (RM)	Cost (RM)
2. Data Import and Input of Tabular Information			
(1) Cadastral Map (data conversion)	1,200 files	10	12000
(2) Hydrological Information	1,100 files	10	11,000
(3) Land Registration Table	500 records	6	3,000
(4) Miscellaneous			5,000
Sub-total			31,000
3. Input of Graphic Information			
(1) Rainfall Intensity Curve at IPOH	1 sheet	300	300
(2) Channel Profile 1	1 sheet	300	300
(3) Profile of River Channel Flow Capacity	1 sheet	300	300
(4) Annual Trend of Water Quality	3 sheets	300	800
(5) Historical Logging Volume	1 sheet	300	300
Sub-total			1,900
Grand Total			937,500

Table 7-6 CASH FLOW OF ECONOMIC COST AND BENEFIT OF THE OPERATIONAL SYSTEM ESTABLISHED IN THE STUDY PERIOD

(Unit: RM million)

Year	(1) Investment Cost	(2) Accumulated Investment Cost	(3) Maintenance Cost *	(4) Total Cost (1)+(3)	(5) Full Benefit	(6) Actual Benefit	(7) (1)-(6)
1998	2.92	2.92		2.92			2.92
1999			0.21	0.21	0.00	0.84	-0.63
2000			0.21	0.21	0.00	0.84	-0.63
2001			0.21	0.21	0.00	0.84	-0.63
2002			0.21	0.21	0.00	0.84	-0.63
2003			0.21	0.21	0.00	0.84	-0.63
2004			0.21	0.21	0.00	0.84	-0.63
2005			0.21	0.21	0.00	0.84	-0.63
2006			0.21	0.21	0.00	0.84	-0.63
2007			0.21	0.21	0.00	0.84	-0.63
2008			0.21	0.21	0.00	0.84	-0.63
Total	2.92	2.92	2.10	5.02	0.00	8.40	
						EIRR=	17.1%

Table 8-1 MEMBER OF PROPOSED STEERING COMMITTEE FOR THE RIVER BASIN INFORMATION SYSTEM

Designation	Name of Government Agencies
Chairman	Secretary General of Ministry of Agriculture
Secretariat	Information Technology Unit, Ministry of Agriculture and River Division, Department of Irrigation and Drainage, Ministry of Agriculture
Members	(a) Economic Planning Unit, Prime Minister's Department (b) State Representatives (c) Malaysian Administrative & Management Unit, Prime Minister's Department (as the representative of National Data Processing Committee) (d) Department of Survey and Mapping (as the representative of National Mapping Committee) (e) Ministry of Land Cooperative Development (as the representative of the NaLIS Central Council) (f) Malaysian Institute of Micro-electric Systems (as the representative of the National Information Technology Council)) (g) Malaysian Center for Remote Sensing (as the representative of the National Remote Sensing Committee) (h) National Hydraulic Research Institute, Malaysia (i) Department of Irrigation and Drainage

Table 8-2 MEMBER OF PROPOSED TECHNICAL COMMITTEE FOR THE RIVER BASIN INFORMATION SYSTEM

Designation	Name of Government Agencies
Chairman	Director General of Department of Irrigation and Drainage, Ministry of Agriculture
Secretariat	River Division, Department of Irrigation and Drainage, Ministry of Agriculture
Members of Federal Agency	(a) Department of Irrigation and Drainage (Hydrology Division); (b) Department of Survey and Mapping, Malaysia as the data source of topographic map information; (c) Department of Agriculture as the data source of land use and soil map; (d) Department of Environment as the data source of river water quality and basin pollutant source; (e) Malaysia Meteorological Service as the data source of meteorological information source; (f) Department of Geological Survey of Malaysia as the data source of geographic map information; (g) Department of Statistics as the source of socio-economic census data; and (h) Public Work Department as the data source of bridges.
Members of State Agency	(a) Economic Planning Unit as the data source of state development plan; (b) Department of Irrigation and Drainage as the data source of telemetry gauging data, and at the same time, as the water user for irrigation; (c) Perak Water Board as the water user of domestic and industrial water supply; (d) Forest Department as the data source on basin forest conditions; (e) Yayasan Perak as the data source of echo-tourism on Perak river; (f) TNB as the data source of dam information; (g) Department of Environment as the data source of river water quality and basin pollutant source; and (h) Town and Country Planning Department as the data source of structural plans. (i) All other state authorities designated as data source and/or data user of RBIS (j) All local authorities designated as data source and/or data users of RBIS

Table 9-1 FLOW REGIME AND NUMBER OF DAYS TO EXCEED CRITICAL MINIMUM DISCHARGE

(1) Item of Daily Discharge	(2) Critical Minimum Discharge	Year	Flow Regime			Number of Days			
			Ave.	95% Exceeding	Min.	(3) Days of (1)>(2)	(4) Days of (1)<(2)	(5) Days of Non-recording	(6) (3)/((3)+(4))
Outflow from Chenderoh Dam	84.9 m3/s* (3000 cusec)	1986	180	104	96	314	0	51	100%
		1987	211	119	97	324	0	41	100%
		1988	359	237	187	95	0	271	100%
		1989	190	118	100	278	0	87	100%
		1990	171	91	77	285	7	73	98%
		1991	170	103	82	339	1	25	100%
		1992	145	95	37	321	8	37	98%
		1993	153	72	33	205	17	143	92%
		Total	183	98	33	2,161	33	728	98%
Runoff Discharge from Pelus River Basin	28.3 m3/s** (1000 cusec)	1986	29	19	18	151	182	32	45%
		1987	45	19	18	145	190	30	43%
		1988	35	15	7	242	117	7	67%
		1989	41	22	21	255	51	59	83%
		1990	28	17	15	99	222	44	31%
		1991	31	12	5	127	213	25	37%
		1992	31	17	15	148	187	31	44%
		1993	42	23	22	173	68	124	72%
		Total	35	17	5	1,340	1,230	352	52%
Flow Discharge at Iskandar Bridge	113.2 m3/s** (4000 cusec)	1986	205	128	122	346	0	19	100%
		1987	261	140	117	354	0	11	100%
		1988	395	251	228	95	0	271	100%
		1989	226	147	133	337	0	28	100%
		1990	193	108	93	300	30	35	91%
		1991	199	123	112	362	3	0	99%
		1992	175	116	78	350	10	6	97%
		1993	213	121	100	329	5	31	99%
		Total	217	123	78	2,473	48	401	98%

* : Minimum outflow discharge from Chenderoh Dam
** : Minimum runoff to guarantee the discharge at Iskandar bridge in case of dam out flow of 3000 cusec
***: Minimum flow discharge to be guaranteed by outflow from Chenderoh Dam

Table 9-2 WATER DEFICIT OF PERAK RIVER AT ISKANDAR BRIDGE

Year	Deficit Period	Number of Deficit Days	Average Deficit (m3/s)	Maximum Deficit (m3/s)
1990	Aug. 04 - Aug. 05	2	1.25	1.44
	Aug. 12 - Aug. 12	1	7.65	7.65
	Aug. 14 - Aug 14	1	0.53	0.53
	Aug. 16 - Aug. 22	7	8.91	17.76
	Aug. 24 - Aug. 27	4	9.09	20.12
	Sep. 02 - Sep.16	15	5.80	11.03
1991	Jul. 14 - July 14	1	0.27	0.27
	Sep. 01 Sep. 01	1	0.30	0.30
1992	Jan. 20 - Jan. 20	1	5.87	5.87
	Jan. 30 - Jan. 31	2	0.40	0.58
	Feb. 04 - Feb. 04	1	0.83	0.83
	Mar. 15 - Mar. 15	1	5.05	5.05
	Mar. 22 - Mar. 22	1	8.11	8.11
	Oct. 04 - Oct. 05	2	16.50	33.00
	Oct. 07 - Oct. 08	2	23.84	35.36
	Sep. 20 - Sep. 20	1	13.69	13.69
1993	Apr. 10 -Apr. 10	1	6.34	6.34
	Aug. 09 - Aug. 10	2	4.06	5.99
	Aug. 12 - Aug. 12	1	1.69	1.69
	Sep. 20 - Sep. 20	1	13.69	13.69
Total		48	7.12	35.36

Note: Deficit is counted when the daily average flow discharge at Iskandar Bridge is less than 4000cusec (113.2m3/s).

Table 9-3 DAM RESERVOIR VOLUME TO MAINTAIN THE GUARANTEED DISCHARGE AT ISKANDAR BRIDGE

Date			(1) Observed Outflow from Dam (m^3/s)	(2) Observed Discharge at Iskandar Bridge (m^3/s)	(3) Observed Deficit * at Iskandar Bridge (m^3/s)	(4) Revised ** Outflow from Dam (m^3/s)	(5) Reservoir Volume Used to Supply the Deficit ((4)-(1)) x 86,400 (10^3 m^3)
Year	Mon.	Day					
1990	Aug.	16	94.1	111.2	2.0	96.1	172.8
1990	Aug.	17	93.7	112.7	0.5	94.2	47.5
1990	Aug.	18	89.9	107.5	5.7	95.5	489.9
1990	Aug.	19	91.2	108.4	4.8	96.0	414.7
1990	Aug.	20	82.2	99.3	13.9	96.2	1203.6
1990	Aug.	21	78.5	95.5	17.7	96.2	1528.4
1990	Aug.	22	78.5	95.4	17.8	96.3	1534.5
1990	Aug.	23	120.8	137.5	0.0	96.5	-2095.2
1990	Aug.	24	84.0	100.7	12.5	96.5	1081.7
1990	Aug.	25	78.2	94.8	18.4	96.6	1588.9
1990	Aug.	26	76.5	93.1	20.1	96.7	1738.4
1990	Aug.	27	76.9	93.3	19.9	96.9	1720.2
1990	Aug.	28	117.1	133.5	0.0	96.9	-1749.6
1990	Aug.	29	140.0	156.4	0.0	96.8	-3735.1
1990	Aug.	30	132.6	150.6	0.0	95.2	-3231.4
1990	Aug.	31	95.2	115.0	0.0	93.4	-158.1
1990	Sep.	1	126.5	143.6	0.0	96.1	-2622.2
1990	Sep.	2	88.1	108.0	5.2	93.3	452.7
1990	Sep.	3	85.3	103.5	9.7	95.1	838.9
1990	Sep.	4	89.4	107.1	6.1	95.5	527.0
1990	Sep.	5	87.0	104.0	9.2	96.2	796.6
1990	Sep.	6	85.2	102.2	11.0	96.3	953.0
1990	Sep.	7	85.4	102.2	11.0	96.4	951.3
1990	Sep.	8	92.8	113.1	0.1	92.9	8.6
1990	Sep.	9	91.4	108.6	4.6	96.1	398.3
1990	Sep.	10	91.4	108.4	4.8	96.2	415.6
1990	Sep.	11	84.9	104.4	8.8	93.7	756.9
1990	Sep.	12	84.9	106.3	6.9	91.8	594.4
1990	Sep.	13	84.9	111.7	1.6	86.5	133.9
1990	Sep.	14	84.9	110.6	2.6	87.5	222.0
1990	Sep.	15	84.9	109.7	3.5	88.4	302.4
1990	Sep.	16	84.9	111.4	1.9	86.8	159.8
			Ave. 92.5	Ave. 111.2	Ave. 6.9	Ave. 94.5	Total 5440.6 ***

* : Deficit to the guaranteed discharge of 4,000cusec (113.2 m3/s)

**: Outflow discharge to guarantee the discharge of 4,000cusec (113.2m3/s) at Iskandar Bridge

***: Corresponds to about 11cm in deference of reservoir water level of Temengor Dam

Table 9-4 FLOOD DAMAGE FACTOR

Item	Flood Depth	Flood Duration	Damage Factor (%)	Remarks
Paddy (Production loss)	less than 0.5m	less than 2 days	30	
		3 to 4 days	37	
		5 to 6 days	40	
		more than 7 days	45	
	0.5 to 0.9 m	less than 2 days	33	
		3 to 4 days	40	
		5 to 6 days	43	
		more than 7 days	49	
	more than 1 m	less than 2 days	60	
		3 to 4 days	80	
		5 to 6 days	86	
		more than 7 days	96	
Rubber (Mortality of young tree)	more than 0.25 m	less than 7 days	5	Assume 9% of total planted area to be subject to mortality
		8 to 14 days	15	
		15 to 21 days	60	
		more than 22 days	100	
Oil Palm/Coconuts Palm (Mortality of young tree)	more than 0.25 m	less than 7 days	10	Assume 9% of total planted area to be subject to mortality
		8 to 14 days	20	
		15 to 21 days	70	
		more than 22 days	100	
Other Tree Crops (Mortality of young tree)	more than 0.25 m	less than 4 days	10	Assume 10% of total planted area to be subject to mortality
		5 to 8 days	25	
		9 to 12 days	60	
		more than 13 days	70	
House/Building	less than 0.5 m		3	
	0.5 to 1.0 m		5	
	1.0 to 2.0 m		7	
	2.0 to 3.0 m		11	
	more than 3 m		15	

Source: National Water Resources Study, Malaysia , Sectoral Report Vol. 5, Oct. 1982

Table 9-5 ESTIMATED PROBABLE FLOOD DAMAGE OF PERAK RIVER UNDER CONDITION OF PRESENT DAM OPERATION

Item of Damage	Area Inundated	Quantity Damaged	Unit Value	10-year Flood		20-year-Flood		50-year Flood		100-year Flood	
				Duration (days) [1]	2.4	Duration (days) [1]	2.6	Duration (days) [1]	3.8	Duration (days) [1]	5.4
				Depth (m) [2]	0.5	Depth (m) [2]	0.9	Depth (m) [2]	1.7	Depth (m) [2]	2.8
				Damage Factor	Flood Damage (10^3RM)	Damage Factor	Flood Damage (10^3RM)	Damage Factor	Flood Damage (10^3RM)	Damage Factor	Flood Damage (10^3RM)
1. Direct Agricultural Damage											
1.1 Paddy	1,200 ha	1,200 ha	1,500 RM/ha	0.40	720	0.40	720	0.80	1,440	0.86	1,548
1.2 Rubber (Production Loss)	2,800 ha	2,800 ha	47 [3] RM/ha	1.19 [4]	156	1.31 [4]	173	1.92 [4]	252	2.71 [4]	356
1.3 Rubber (Mortality Loss)	2,800 ha	252 ha	5,200 RM/ha	0.05	66	0.05	66	0.05	66	0.05	66
1.4 Oil Palm (Mortality Loss)	2,500 ha	225 ha	3,500 RM/ha	0.10	79	0.10	79	0.10	79	0.10	79
1.5 Coconut Palm (Mortality Loss)	1,000 ha	60 ha	6,200 RM/ha	0.10	37	0.10	37	0.25	93	0.25	93
1.6 Other Tree Crop (Mortality Loss)	1,200 ha	120 ha	6,400 RM/ha	0.10	77	0.10	77	0.25	192	0.25	192
1.7 Mix Horticulture	4,000 ha	4,000 ha	4,699 RM/ha	0.10	1,880	0.10	1,880	0.25	4,699	0.25	4,699
Sub-Total (for 1.)					3,014		3,031		6,821		7,033
2. Direct Non-Agriculture Damage											
2.1 Private House		5,000 houses	11,000 RM/house	0.05	2,750	0.05	2,750	0.07	3,850	0.11	6,050
2.2 Shops & Commercial Sites		250 sites	13,000 RM/sites	0.05	163	0.05	163	0.07	228	0.11	358
2.3 Industrial Facilities		60,000 m^2	800 RM/m^2	0.05	2,400	0.05	2,400	0.07	3,360	0.11	5,280
2.4 Road		40 km	15,000 RM/km	1.00	600	1.00	600	1.00	600	1.00	600
Sub-Total (for 2.)					5,913		5,913		8,038		12,288
3. Indirect Damage											
3.1 Agricultural Damage [4]					603		606		1,364		1,407
3.2 Private/Public Houses [5]					4,369		4,369		6,116		9,611
3.3 Transportation [6]					600		600		600		600
Sub-total (for 3.)					5,572		5,575		8,080		11,618
Damage Total					14,498		14,518		22,938		30,938

Note:
(1): Duration of flood discharge over 850m3/s
(2): Maximum flood inundation depth
(3): 9.4kg/ha/day x RM5/kg
(4): Flood duration x 1/2
(5): 20% of "1. Direct Agricultural Damage"
(6): 150% of ("2.1 Direct Damage of Private House" + "2.2 Shops & Commercial Sites")
(7): 100% of "2.4 Direct Damage of Road"

Table 9-6 ESTIMATED PROBABLE FLOOD DAMAGE OF PERAK RIVER UNDER CONDITION OF PROPOSED DAM OPERATION

Item of Damage	Area Inundated	Quantity Damaged	Unit Value	10-year Flood		20-year-Flood		50-year Flood		100-year Flood	
				Duration (days) [1] Depth (m) [2]	2.3 0.3	Duration (days) [1] Depth (m) [2]	2.4 0.4	Duration (days) [1] Depth (m) [2]	3.8 1.4	Duration (days) [1] Depth (m) [2]	5.4 2.5
				Damage Factor	Flood Damage (10^3RM)	Damage Factor	Flood Damage (10^3RM)	Damage Factor	Flood Damage (10^3RM)	Damage Factor	Flood Damage (10^3RM)
1. Direct Agricultural Damage											
1.1 Paddy	1,200 ha	1,200 ha	1,500 RM/ha	0.37	666	0.37	666	0.80	1,440	0.86	1,548
1.2 Rubber (Production Loss)	2,800 ha	2,800 ha	47 [3] RM/ha	1.13 [4]	148	1.21 [4]	159	1.92 [4]	252	2.71 [4]	356
1.3 Rubber (Mortality Loss)	2,800 ha	252 ha	5,200 RM/ha	0.05	66	0.05	66	0.05	66	0.05	66
1.4 Oil Palm (Mortality Loss)	2,500 ha	225 ha	3,500 RM/ha	0.10	79	0.10	79	0.10	79	0.10	79
1.5 Coconut Palm (Mortality Loss)	1,000 ha	60 ha	6,200 RM/ha	0.10	37	0.10	37	0.25	93	0.25	93
1.6 Other Tree Crop (Mortality Loss)	1,200 ha	120 ha	6,400 RM/ha	0.10	77	0.10	77	0.25	192	0.25	192
1.7 Mix Horticulture	4,000 ha	4,000 ha	4,699 RM/ha	0.10	1,880	0.10	1,880	0.25	4,699	0.25	4,699
Sub-Total (for 1.)					2,952		2,963		6,821		7,033
2. Direct Non-Agriculture Damage											
2.1 Private House		5,000 houses	11,000 RM/house	0.03	1,650	0.03	1,650	0.07	3,850	0.11	6,050
2.2 Shops & Commercial Sites		250 sites	13,000 RM/sites	0.03	98	0.03	98	0.07	228	0.11	358
2.3 Industrial Facilities		60,000 m^2	800 RM/m^2	0.03	1,440	0.03	1,440	0.07	3,360	0.11	5,280
2.4 Road		40 km	15,000 RM/km	1.00	600	1.00	600	1.00	600	1.00	600
Sub-Total (for 2.)					3,788		3,788		8,038		12,288
3. Indirect Damage											
3.1 Agricultural Damage [4]					590		593		1,364		1,407
3.2 Private/Public Houses [5]					2,621		2,621		6,116		9,611
3.3 Transportation [6]					600		600		600		600
Sub-total (for 3.)					3,812		3,814		8,080		11,618
Damage Total					10,551		10,564		22,938		30,938

Note:
(1): Duration of flood discharge over 850m3/s
(2): Maximum flood inundation depth
(3): 9.4kg/ha/day x RM5/kg
(4): Flood duration x 1/2
(5): 20% of "1. Direct Agricultural Damage"
(6): 150% of ("2.1 Direct Damage of Private House" + "2.2 Shops & Commercial Sites")
(7): 100% of "2.4 Direct Damage of Road"

Table 9-7 ESTIMATED ANNUAL AVERAGE FLOOD DAMAGE

Under Condition of Present Dam Operation

(1) Return Period	(2) Occurrence Probability 1/(1)	(3) Probable Damage	(4) Occurrence Probability between $D_{(i-1)}$ and $D_{(i)}$ $(P_{(i-1)} - P_{(i)})$	(5) Average Damage between $D_{(i-1)}$ and $D_{(i)}$ $(D_{(i-1)} + D_{(i)})/2$	(6) Probable Damage between $D_{(i-1)}$ and $D_{(i)}$ (4) x (5)
		(10^3 RM)		(10^3 RM)	(10^3 RM)
2 -year	$P_{(1)}$= 0.50	$D_{(1)}$= 0	-	-	
10 -year	$P_{(2)}$= 0.10	$D_{(2)}$= 14,498	0.40	7,249	2,900
20 -year	$P_{(3)}$= 0.05	$D_{(3)}$= 14,518	0.05	14,508	725
50 -year	$P_{(4)}$= 0.02	$D_{(4)}$= 22,938	0.03	18,728	562
100 -year	$P_{(5)}$= 0.01	$D_{(5)}$= 30,938	0.01	26,938	269
Annual Average Flood Damage (Total of (6))					4,456

Under Condition of Proposed Dam Operation

(1) Return Perio	(2) Occurrence Probability 1/(1)	(3) Probable Damage	(4) Occurrence Probability between $D_{(i-1)}$ and $D_{(i)}$ $(P_{(i-1)} - P_{(i)})$	(5) Average Damage between $D_{(i-1)}$ and $D_{(i)}$ $(D_{(i-1)} + D_{(i)})/2$	(6) Probable Damage between $D_{(i-1)}$ and $D_{(i)}$ (4) x (5)
		(10^3 RM)		(10^3 RM)	(10^3 RM)
2 -year	$P_{(1)}$= 0.50	$D_{(1)}$= 0			
10 -year	$P_{(2)}$= 0.10	$D_{(2)}$= 10,551	0.40	5,276	2,110
20 -year	$P_{(3)}$= 0.05	$D_{(3)}$= 10,564	0.05	10,558	528
50 -year	$P_{(4)}$= 0.02	$D_{(4)}$= 22,938	0.03	16,751	503
100 -year	$P_{(5)}$= 0.01	$D_{(5)}$= 30,938	0.01	26,938	269
Annual Average Flood Damage (Total of (6))					3,410