

CHAPTER 6

LANDUSE MASTERPLAN STUDY

6.0 LAND-USE MASTERPLAN STUDY

6.1 INTRODUCTION

6.1.1 The Putrajaya Lake system is a man-made system. For it to perform as envisaged there is a need to develop an integrated land-use masterplan for the catchment, based on an adequate understanding of the natural system supporting it.

6.1.2 To develop the masterplan there is a need to review the existing land-use policies and land-use situation in the catchment. Based on the review and the land-use controls, recommended by the various specialists in the study team to ensure the success and sustainability of the Lake, an integrated land-use masterplan can then be developed to guide the future development in the catchment.

6.2 REVIEW OF LAND-USE POLICIES AND GUIDELINES

6.2.1 The Structure Plans

6.2.1.1 The current land-use policy in the catchment is governed by two district Structure Plans. They are:

- The Structure Plan for Putrajaya and part of Sepang District
- The Structure Plan for Petaling District and part of Klang District

6.2.1.2 The Structure Plan for Putrajaya and part of Sepang District has defined a set of policies for the planning and development of Putrajaya. The policies governing the planning and management of the area in the Putrajaya Lake Catchment are supposed to create a city possessing the following characteristics:

- an “intelligent City”
- a “City-in-a-Garden”
- a city that meets the administrative needs of the federal government
- a city with a carefully monitored physical and ambient environment
- a city with a high quality living environment
- a city that gives priority to public transport

6.2.1.3 The Structure Plan also supported preservation of the existing development surrounding Putrajaya. They are;

- *Golf Course & Country Homes (IOI)*
 - The activities must be control
 - High management standard of environment, with centralised sewage treatment system
- *Gas Turbine Power Station (TNB)*
 - expansion of existing capacity are not allowed
 - Water pollutant must be controlled
- *West Country Estate*
 - Can be developed for low-density development, such as institution, recreation and green area.
- *Bukit Bisa*
 - Can be developed for low density development
- *Kawasan Rezab Melayu*
 - Land conversion from agriculture to industry is strictly prohibited. The developments in this area are to be encouraged for housing. However, other developments such as commercial, recreation, golf course, tourism etc. have to be screened thoroughly to ensure the development concept for the Putrajaya and Sepang Structure Plan are in line with each other.

6.2.1.4 Basically, the existing and committed developments within the catchment is in line with the general policies of the Structure Plan. The developments are compatible for developing such low-density development and are environmental friendly and integrated with the Putrajaya development concepts.

6.2.1.5 The Structure Plan for the Petaling District and part of Klang District also emphasises on the need to preserve the environment, wherever possible, and to create a green landscape. The pertinent policies are:

- Development without negative impact to the environment
- Preservation of forest reserve and water catchment area

- Future development must have reservation for recreation and open space
- Preservation of water sources
- Utilities reserve must be landscaped.

6.2.1.6 The Consultant has carefully reviewed the policies and objectives described in the above two Structure Plans. The thrust of the policies in the two Plans is to balance rapid development growth in the area with the preservation of the natural environment through low density development. Thus, in the development of the integrated land-use masterplan for the catchment the Consultant will be guided by that concept.

6.2.2 The Putrajaya Land-use Masterplan

6.2.2.1 The land-use Masterplan for Putrajaya (see Figure 6.1), also known as the ‘Master Plan’, was approved by the Perbadanan Putrajaya on 31st March 1997.

6.2.2.2 The Master Plan reaffirms the concepts of an “intelligent City” and a “City-in-a-Garden” as defined in the Structure Plan. The Master Plan reinforces the concept of a “City-in-a-Garden” by proposing “an integrated system of parks, water courses, wetlands, forest and open spaces...”

6.2.3 The Putrajaya Urban Design Guidelines (UDG)

6.2.3.1 To support and ensure the successful attainment of the vision for Putrajaya and its Lake system, a set of detailed Urban Design Guidelines (UDG) has been prepared. The UDG provides detail guidelines on the design parameters and control for different land parcels in the Putrajaya area.

6.2.3.2 A review of the UDG was also carried out with the objective of incorporating pertinent elements of the UDG in the development guidelines for the catchment areas outside of the Putrajaya area. The following are a few pertinent UDG which were adopted by the Consultants to guide their preparation for the development guidelines at the catchment areas outside of the Putrajaya area.

- Urban Design Guidelines (Vol. 1 – Rationale and Strategies)
- Urban Design Guidelines (Vol. 2 – Development Controls)

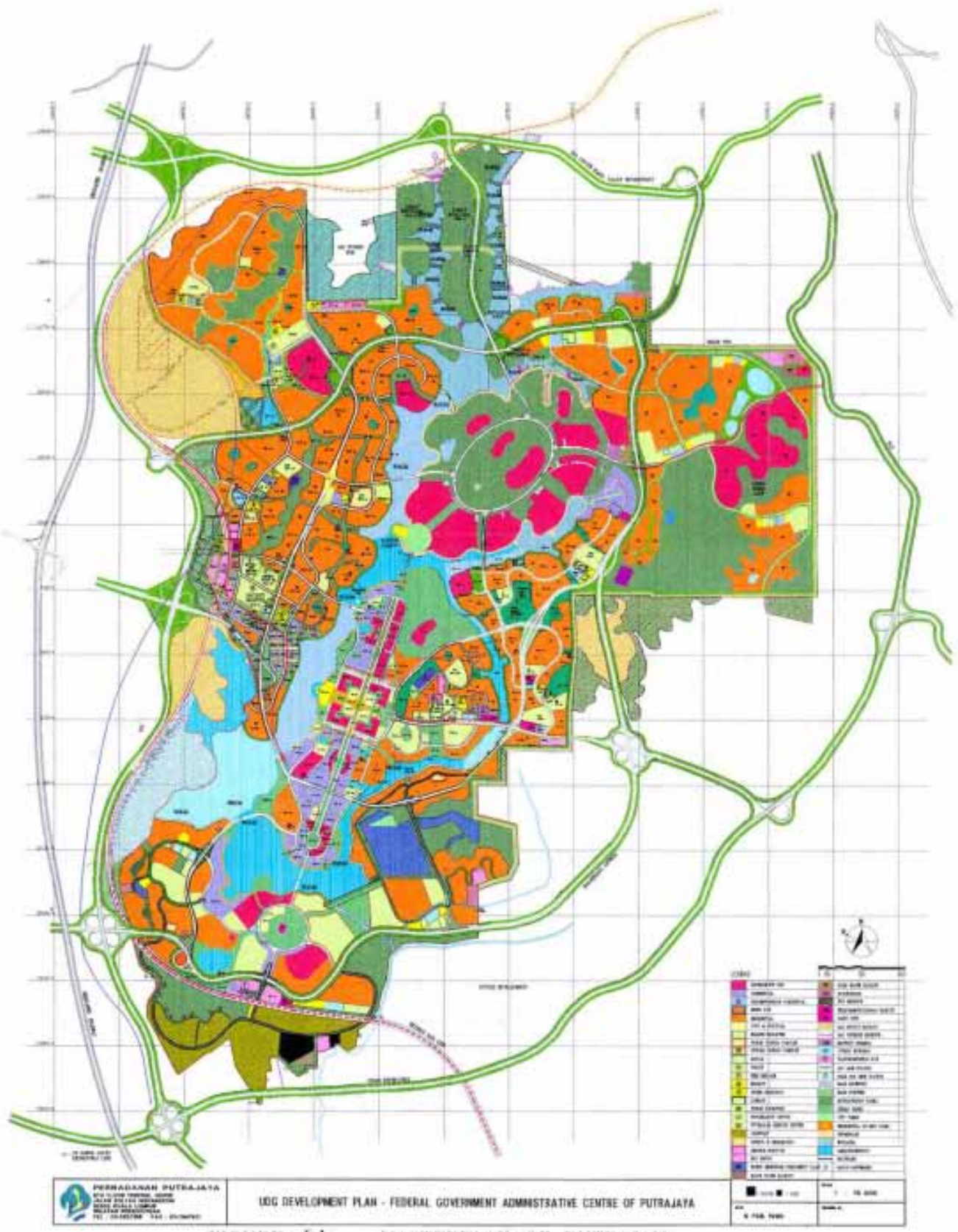


FIGURE 6.1 MASTERPLAN OF PUTRAJAYA

- Urban Design Analysis and Strategies (Vol. 1 – Rationale and Strategies)
- Urban Design Analysis and Strategies (Vol. 2A – Precincts Analysis and Development Plan. Precinct 7, 8, 9 and 10)
- Urban Design Analysis and Strategies (Vol. 3 – Part 1: Residential and Residential Centres)
- Urban Design Analysis and Strategies (Vol. 3 – Part 4: Service Industry, Transport and Public Utilities)
- Urban Design Analysis and Strategies (Vol. 3 – Part 5a & 5b: Landscape, etc.)

6.2.3.3 The UDG also give emphasis on the preservation of greenery with low density development. Therefore, planning for future developments in the catchment areas outside of Putrajaya needs to adhere will follow closely to the guidelines defined in the UDG.

6.2.4 Multimedia Super Corridor (MSC) Guidelines

6.2.4.1 The MSC Guidelines were prepared to facilitate local authorities and developers in the planning and development of the MSC. This is in line with the vision of the government to achieve the desired environment for multimedia and IT development. There are seven planning areas within the MSC where this set of guidelines are applicable. Only three planning areas are pertinent to this study. They are as follows;

- Cyberjaya
- Tele-suburb
- Research and Development (R&D) Centre

6.2.4.2 The basic planning of the MSC is based on the following development principles;

1. Human oriented intelligent city in harmony with nature.
2. Harmonious relation between Man and His Creator, Man and Man, Man and Technology and Man and Environment.
3. Low density living environment.
4. Ecological and environmental planning with lush tropical landscape.
5. Human focus design with ‘barrier free’ living.
6. Advanced telecommunication infrastructure for the multimedia/IT industries.
7. Comfortable and efficient urban infrastructure.

6.3 EXISTING AND COMMITTED LAND-USE SITUATION

6.3.1 Introduction

6.3.1.1 The Putrajaya Lake catchment has a total area of 14,982 acres or 6,066 ha. It can be divided into two distinct areas – the Putrajaya area with a size of 10,600 acres (4,291 ha.) and the areas outside of it with a size of 4,382 acres (1,774ha.)

6.3.1.2 The existing and future land-use in the Putrajaya area is governed by the Putrajaya Masterplan. The land-use in the 20 precincts of Putrajaya is made-up of various types. The residential areas, comprising of various housing types and densities, are located mostly in the Northern part of the Lake. The Southern part of the Lake will be dominated by mixed development, i.e. a mixture of government offices, commercial buildings and high-density residential developments.

6.3.1.3 The existing land-use in the catchment areas outside of the Putrajaya area can generally be categorised as follows:

- Agricultural production
- Forest reserve
- Low density housing
- Institutional
- Corporate centre

6.3.1.4 The major land owners in the areas are:

- Universiti Putra Malaysia (UPM)
- MARDI
- Integrated Oxygen Industries (IOI)
- Tenaga Nasional Berhad (TNB)
- West Country Berhad
- Cyberjaya
- Sungai Merab Malay Reserve
- Universiti Tenaga Nasional (UNITEN)

6.3.1.5 The existing and committed land-use plan in the catchment has been prepared and is given in Table 6.1 and Figure 6.2. Details on the existing land-use for each of the major landowners are described below.

**FIGURE 6.2
EXISTING & COMMITTED
LANDUSE MASTERPLAN**

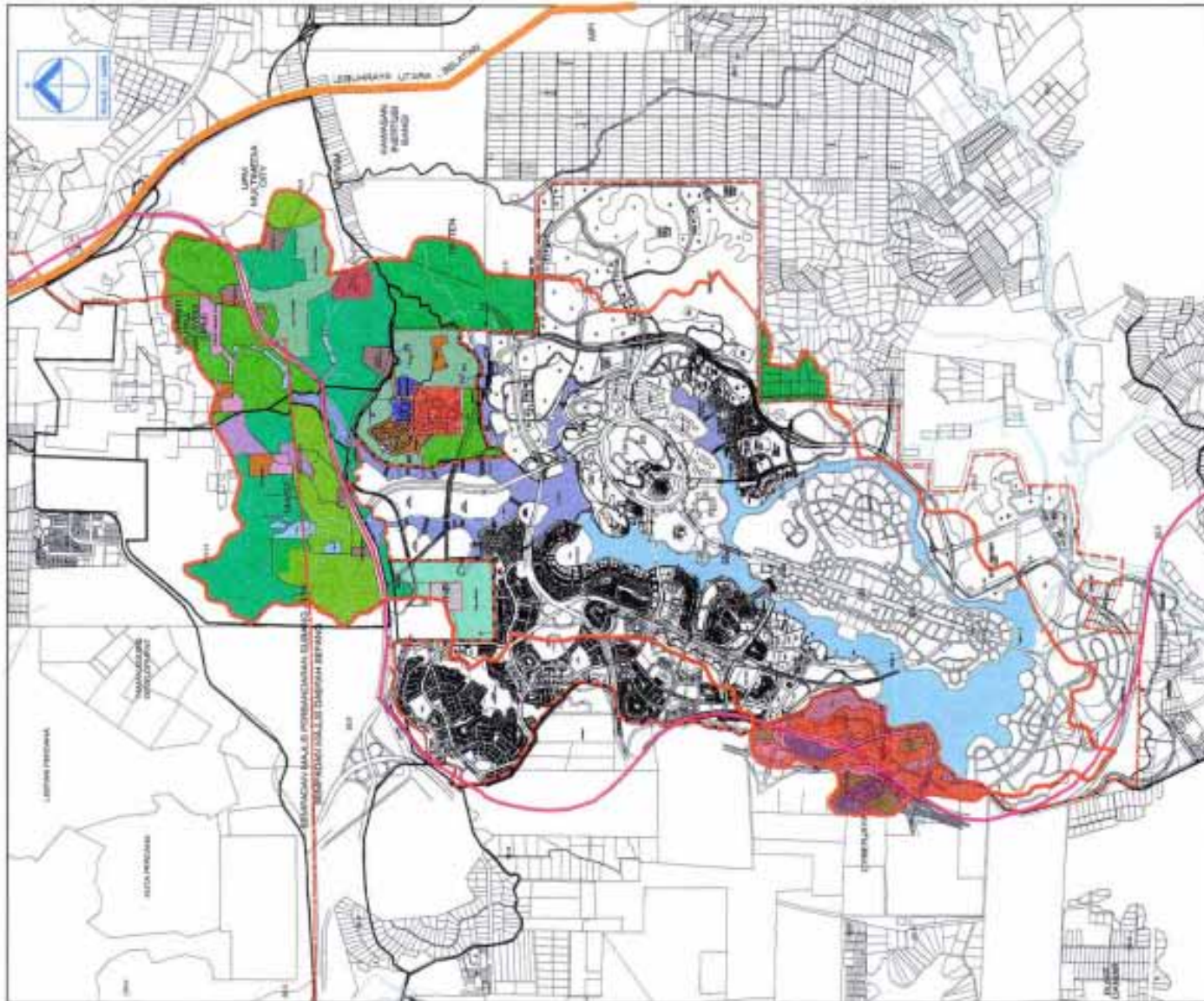


FIGURE	TITLE		
	EXISTING & COMMITTED LANDUSE MASTERPLAN		
CATCHMENT DEVELOPMENT AND MANAGEMENT PLAN FOR PUTRAJAYA LAKE			
BUILDINGS			
	EXISTING (Hm)	COMMITTED (Hm)	
RESIDENTIAL	18.47	13.41	
OFFICE	11.38	12.33	
RESTAURANT	26.76	-	
TURIST/RECREATION	22.50	-	
COMMERCIAL/INDUSTRIAL	11.12	26.41	
CONVENTION CTR	-	-	
SCHOOL	26.28	26.28	
TOTAL	271.11	226.12	
GREEN			
AGRICULTURE	543.22	-	
SOFT SCAPING	462.47	-	
WATERBODIES	194.29	-	
ROADSIDE	712.22	-	
PARK	122.26	-	
SPORTS/RECREATION	462.21	112.22	
TOTAL	2875.22	112.22	
WATER BODIES			
LAKE/POUD	82.22	41.22	
WETLAND	26.22	-	
TOTAL	108.44	41.22	
OTHERS			
ROADWAY	242.22	-	
SEWER/PAVING	-	121.22	
WATER	-	21.22	
OTHER	24.22	-	
TOTAL	270.66	143.66	
GRAND TOTAL		480.00	
REMARKS		ACRES	HECTARE
EXISTING	11,800	4,786.61	
COMMITTED PUTRAJAYA	4,300.00	1,733.40	
TOTAL LANDSCAPE	16,100	6,520.01	

6.3.2 Universiti Putra Malaysia (UPM)

UPM is located at the North of the catchment. It has an area of 2,887 acres (1,168 ha.), however the area within the catchment is 1,390 acres (562 ha.) and most of it is zoned for institutional activities. UPM has been set up as an agricultural and environmental tertiary education centre.

6.3.2.1 Existing and Committed Development

(1) Figure 6.3 shows a plan of the existing land-use in UPM (within Lake catchment) and the boundary of Putrajaya Lake Catchment. Details on the acreage and percentage of the existing and committed land-use in the Lake Catchment are given in Table 6.2. From Table 6.2 it can be seen that the two major land uses in the Lake Catchment are for:

- Sports activities (field, stadium and golf courses) – 28.52%
- Farms and orchards – 46.73%

(2) Currently, the development of UPM is in line with the Putrajaya development concept, i.e. preservation of the environment and greenery. However, the committed development of UPM Hospital located at the edge of the northern side boundary has to take measures to control their waste discharge into the Putrajaya Lake.

(3) Besides the above development, the plans for the future includes a games village for Asia Games 2006 next to the existing stadium, faculty at the northern site of the proposed ERL or next to the Project College and staff quarters within the catchment. Certain areas zoned as 'Flexible Zone' by UPM need careful consideration in order to control its development.

**FIGURE 6.3
EXISTING LANDUSE
UNIVERSITI PUTRA MALAYSIA**

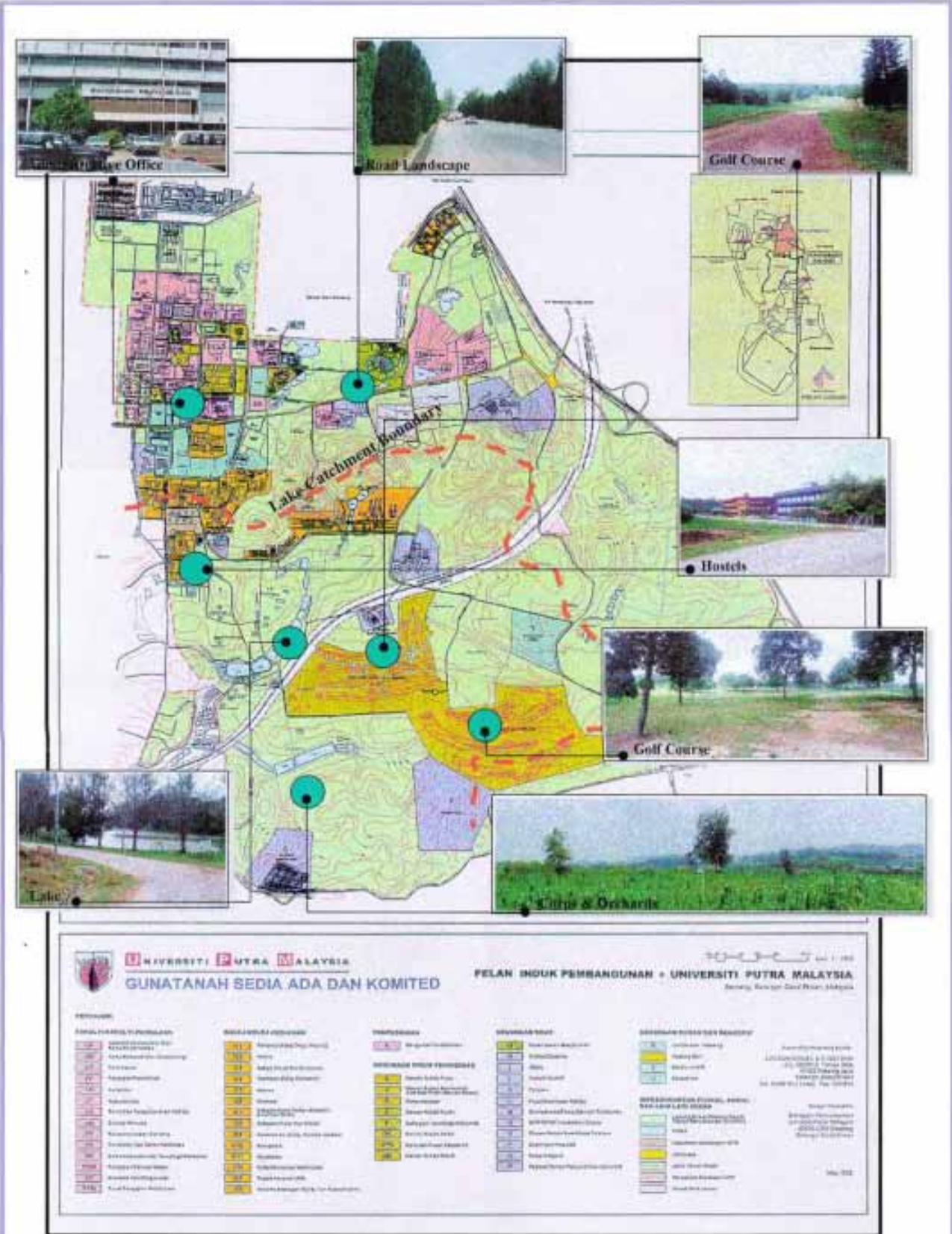


Table 6.2 Existing and Committed Land-use for UPM (Within Catchment)

Landuse/Activities	Area (acre)	Percentage (%)
A. BUILDINGS		
- Hostels	59.76	36.87
- Quarters	3.59	2.21
- Hospital (committed)	43.58	26.89
- Putra Infoport	29.68	18.31
- Others	25.48	15.72
<i>Total</i>	162.09	10.05
B. GREEN AREAS		
- Golf Course	186.51	15.08
- Open space/recreation	209.85	16.97
- Stadium	20.19	1.63
- Farms	321.65	26.01
- Orchards	518.50	40.31
<i>Total</i>	1,236.51	76.56
C. WATER BODIES		
- Lake	24.18	41.20
- Wetland	34.51	58.80
<i>Total</i>	58.69	3.63
D. INFRASTRUCTURE		
- Roads & Drainage	61.57	39.07
- Express Rail Link (Committed)	73.86	46.87
- Kajang Ring Highway	22.17	14.06
<i>Total</i>	157.60	9.76
<i>Grand Total</i>	1,614.89	100.00

6.3.2.1 Physical Characteristics

The topography of UPM is hilly and ranges between 75 to 85 meters, especially at the centre of UPM, with slopes down to the east and south. There are a few lakes/ponds located at the western and southern side with a total area of 24.18 acre (10 ha.)

6.3.2.2 Site Potential & Constraints

- (1) A review of the existing and committed future land-use development of the UPM indicates that they are in line with the development concept of Putrajaya. The preservation of greenery and low-density development meets the requirements of an 'intelligent city' and 'a-City-in-a-Garden' theme.

- (2) The Structure Plan has zoned UPM under 'Institutional' with green and low density mixed development. Therefore, UPM should be developed to preserve the greens within a low-density development accordingly.
- (3) The MSC guideline also stated that the UPM is the R&D Centre and will be a collaborative cluster of academic institutions which offer courses on information technology. On the other hand the corporate R&D centres which undertake research and development oriented industries require close co-operation with the academic and research institutions which are equipped with facilities for laboratory testing, R&D, and skill training centres. An example of such collaboration is the MTDC-UPM Incubation Centre.

6.3.3 MARDI

MARDI is located next to the UPM on the North of Putrajaya. It has a total area of 1,858 acres or 752 ha., and only 1,148 acre (465 ha.) is in the Putrajaya Lake catchment.

6.3.3.1 *Existing and Committed Development*

- (1) To support the development objectives of Putrajaya, MARDI has relocated most of its live stocks rearing activities, which are potential pollutant sources, and are keeping the land as a green area. Currently, there are only a few farms operating on a small scale (20%), rearing chicken, sheep, duck, ostrich, cow, etc. in MARDI's area. There is no committed development around the area except the proposed Express Rail Link (ERL) and South Klang Valley Express (SKVE) at the northern side.
- (2) Figure 6.4 shows a plan of the existing land-use in MARDI. Details on the acreage and percentage of the existing land-use in the MARDI are given in Table 6.3. From Table 6.3 it can be seen that MARDI has preserved 74% of its total area as green areas.

**FIGURE 6.4
MARDI LANDUSE**

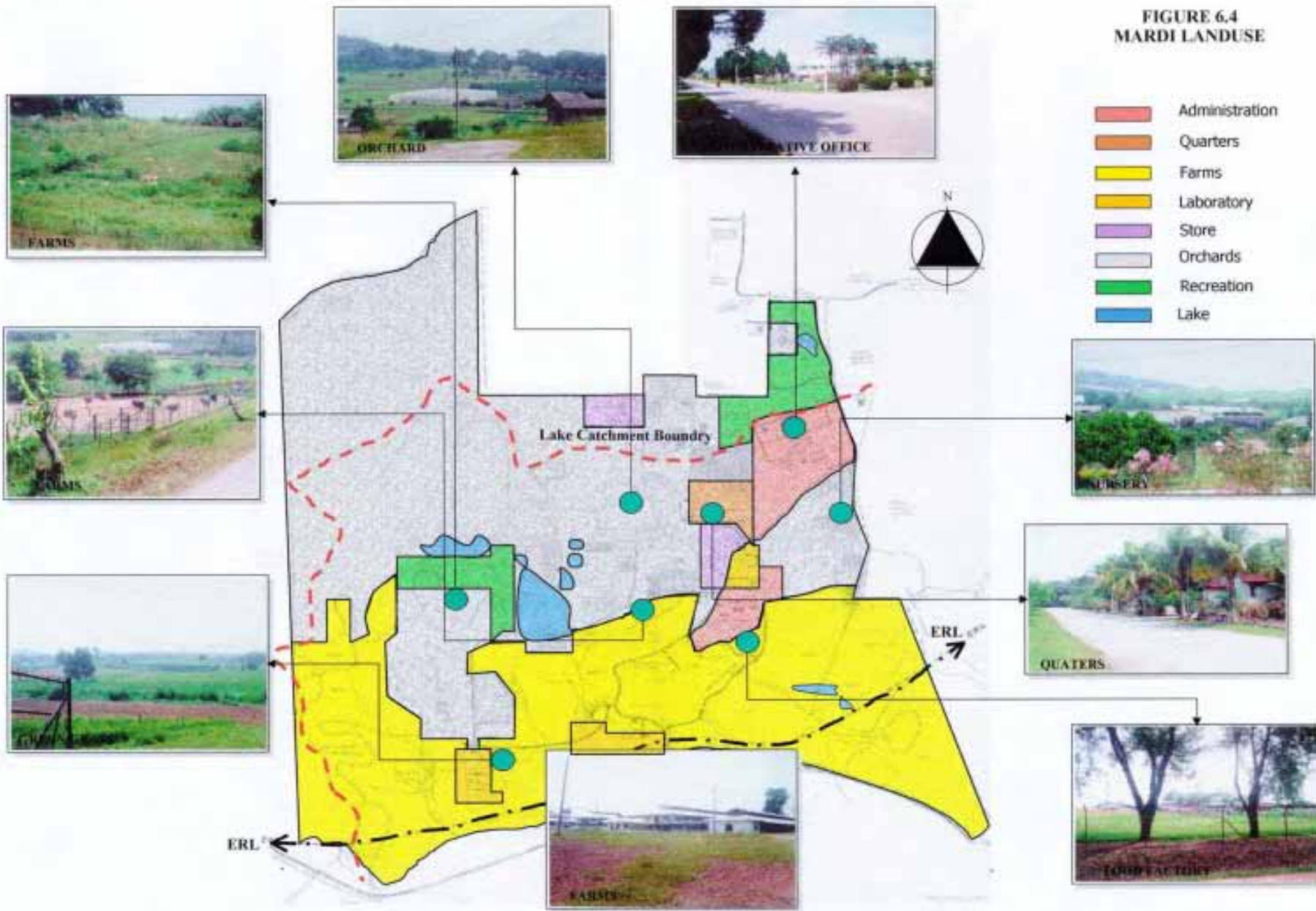


Table 6.3 Existing and Committed Land-use for MARDI

Landuse/Activities	Area (acre)	Percentage (%)
A. BUILDINGS		
- Administration	71.12	61.13
- Laboratory	16.04	13.79
- Quarters	19.30	16.59
- Others	9.88	8.49
<i>Total</i>	116.34	10.13
B. GREEN AREAS		
- Farms	487.35	58.06
- Orchards	321.47	38.30
- Open Space/Recreation	30.56	3.64
<i>Total</i>	839.38	73.08
C. WATER BODY		
- Pond/lake	32.10	72.00
- Wetland	12.48	28.00
<i>Total</i>	44.58	3.88
D. INFRASTRUCTURE		
- Road	53.32	35.97
- Express Rail Link (ERL)	48.32	32.60
- South Klang Valley Highway	46.58	31.43
<i>Total</i>	148.22	12.91
Total Lake Catchment Area	1,148.52	100.00

6.3.3.2 *Physical Characteristic*

- (1) This area is characterised by undulating hills, which ranges from 70 to 80 meters and with slopes to the southern area. The dominant land-use is for agricultural research activities, such as farms and orchards. There are also a few ponds scattered around the area and a lake is also located in the centre of MARDI.
- (2) Basically, the dominant land-use can be categorised into two, which is
 - Orchards at the northern part (58%)
 - Farms at the southern part (38%)

6.3.3.3 *Site Potentials and Constraints*

- (1) A review of the existing and committed future land-use development of the MARDI indicates that they are in line with the development concept of Putrajaya. The preservation of greenery with their Research & Development activities in the

future will meet the requirements of an ‘intelligent city’ and ‘a-City-in-a-Garden’ theme. The environmental friendly concept that MARDI is proposing for its Farms, Orchards Complexes and ponds are in line with the Structure Plans and the Putrajaya concept.

6.3.4 Integrated Oxygen Industries (IOI)

The IOI development, with a size of 418 acres or 170 ha, is located next to the North-Eastern wetlands. Basically, the overall development is in the catchment area, including Bukit Bisa.

6.3.4.1 Existing & Committed Development

- (1) IOI is being developed as a low-density residential area with an average density of 12 units/acre for bungalow and 50 units/acre for condominium, together with commercial lots and a golf course.
- (2) Figure 6.5 shows a plan of the existing land-use in the IOI development. Details on the acreage and percentage of the existing and committed land-use in the IOI development are given in Table 6.4. From Table 6.4 it can be seen that the total percentage of the green area of the development is 42%.

6.3.4.2 Physical Characteristic

The development is located in a hilly area, which ranges between 150 to 225 feet. The highest point of the area is Bukit Bisa (145 meter or 430 feet) (see Figure 6.6). The physical character (hilly) has encouraged the development of low-density condominiums and apartments with bungalow lots. There are 6 ponds with a total area of 7 acres. They act as flood retention ponds at the lowest part of the development.

**FIGURE 6.5
EXISTING LANDUSE
IOI**

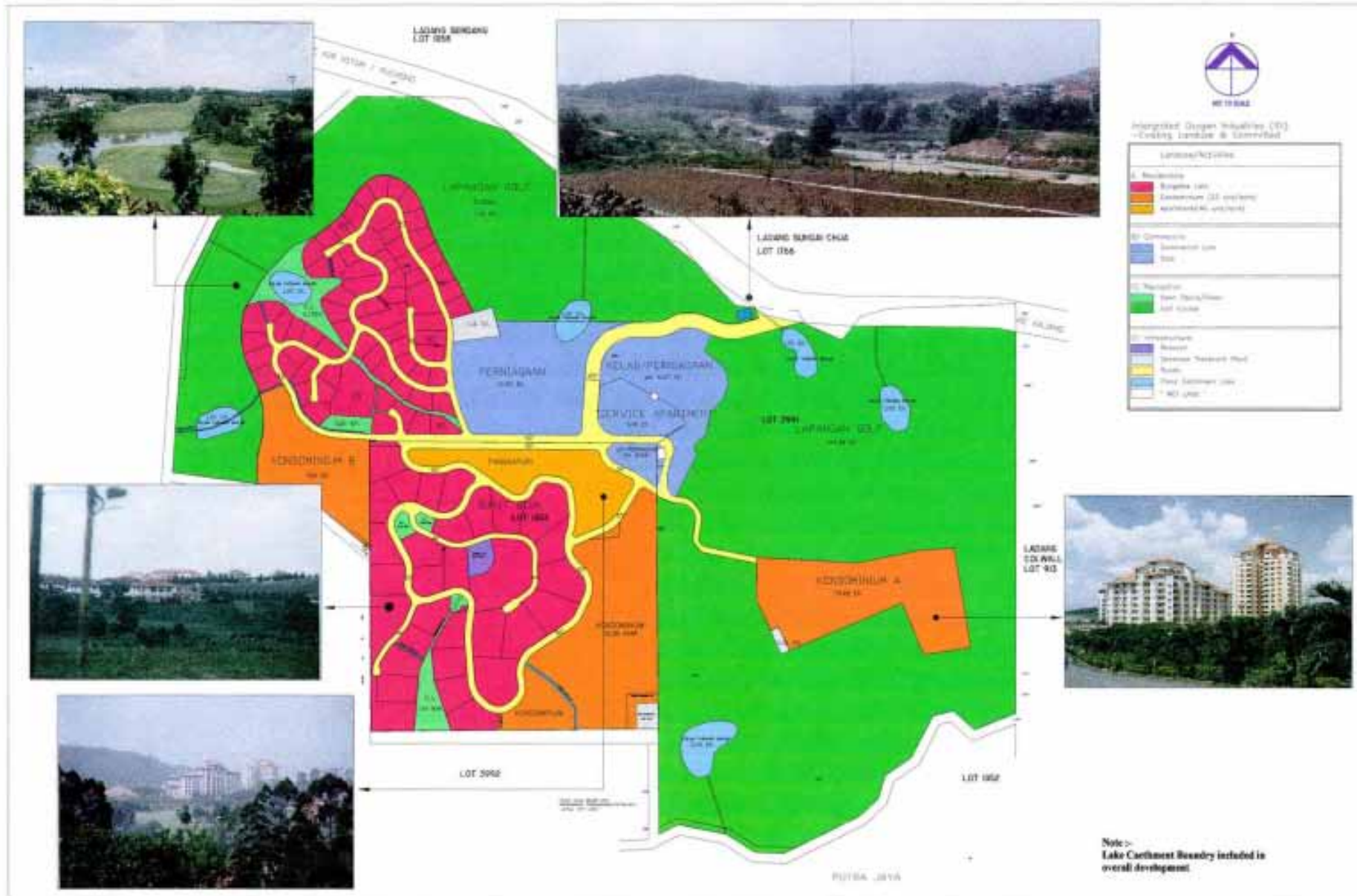




Figure 6.6 : Northern part of Bukit Bisa - with the development of low density mixed housing

Table 6.4 Existing and Committed Land-use for IOI

Landuse/Activities	Unit	Area (acre)	Percentage (%)
A. BUILDINGS			
- Bungalow Lots	101	72.39	44.98
- Condominium (33 unit/acre)	1,737	47.91	29.77
- Apartments (40 unit/acre)	487	11.9	7.39
- Commercial Lots	1	17.46	10.86
- Club	1	11.27	7.00
<i>Total</i>		160.93	30.77
B. GREEN AREAS			
- Open Space/Green		5.82	2.61
- Golf Course		216.90	97.39
<i>Total</i>	-	222.72	42.59
C. WATER BODY			
- Flood Catchment Lake		7.00	100.00
<i>Total</i>	-	7.00	1.34
D. INFRASTRUCTURE			
- Reservoir		0.84	3.08
- Sewerage Treatment Plant		1.99	7.29
- Roads		24.47	89.63
<i>Total</i>	-	27.30	25.30
<i>Total Lake Catchment Area</i>	-	522.91	100.00

6.3.4.3 Site Potentials and Constraints

The development is compatible with that of Putrajaya and follows the Structure Plan. The concept of ‘country homes’, which is a low density residential development and a golf course, is in harmony with the spacious and green living concept emphasised in the Putrajaya development. Basically, the development is already committed and currently the discharge of water into the Putrajaya Lake is under control.

6.3.5 Tenaga Nasional Berhad (TNB)

This site is currently occupied by the Serdang Gas Turbine Power Plant by TNB (see Figure 6.7) with an area of 297 acre (120 ha). However the catchment boundary only takes 75% of the site with the area of 223 acre (90 ha.).



Figure 6.7: TNB Serdang Gas Turbine Power Plant

6.3.5.1 Existing & Committed Development

There are significant stores of chemicals and fuel at this site. Thus, there are potential risks from chemical and fuel spills or explosions. In the event of such an environmental-related emergency at the power plant, there could be significant impacts on the adjacent developments, i.e. the residential and commercial areas.

6.3.5.2 Physical Characteristic

It is located at the northern part of Putrajaya and adjacent to the Taman Wetland and committed mixed housing development in Putrajaya. However, the buffer zone provided around the power station helps to reduce the risk of emergencies.

6.3.5.3 Site Potentials & Constraints

- (1) The impact on the wetlands and the Lake arises primarily from hazardous chemical and fuel spills. Although the risk of such an occurrence is small the impact of such an occurrence could be immense. TNB has to develop emergency response plans to cope with such potential environmental-related emergencies.
- (2) The other possible environmental impacts maybe the fallout from any explosions and the release of toxic gases. The wind direction has generally been observed to be from the North Westerly direction. This has implications on the land uses to the South of the power plant. The land use zoning should take this into consideration.

6.3.6 West Country Berhad

This area is located at the north-eastern edge of Putrajaya and is adjacent to the Wetland and IOI (Bukit Bisa). The existing land-use is oil palm and rubber tree cultivation (see Figure 6.8). However, plans are being made to develop the area at the north-eastern end into a mixed development. The land area is 423 acres (171 ha.). The total land area within the Lake Catchment is 381 acres 9154 ha).



Figure 6.8 : Western part of West Country with proposed low density housing – Bungalow lots, located adjacent to IOI golf course.

6.3.6.1 Existing and Committed Development

Currently there is an oil palm estate with slopes of 5 – 20 degrees. West Country Berhad have tentatively proposed mixed development on their 289 acre land, with low density housing developments on the western part which lies within the lake Catchment.

6.3.6.2 Physical Characteristic

The site is undulating and ranges from 100 – 250 feet. The northern site is sloping to the Putrajaya Lake.

6.3.6.3 Site Potentials & Constraints

There is a proposed highway from Putrajaya cutting through the site at the Western end. Tentatively, this area was proposed for mixed development, i.e. bungalow lots, terrace house, commercial, facilities (school, mosque) etc. This development is still in line with that of the Putrajaya Structure Plan. The proposed lake at the middle of the northern side will help to control the runoff discharge into Putrajaya.

6.3.7 Cyberjaya

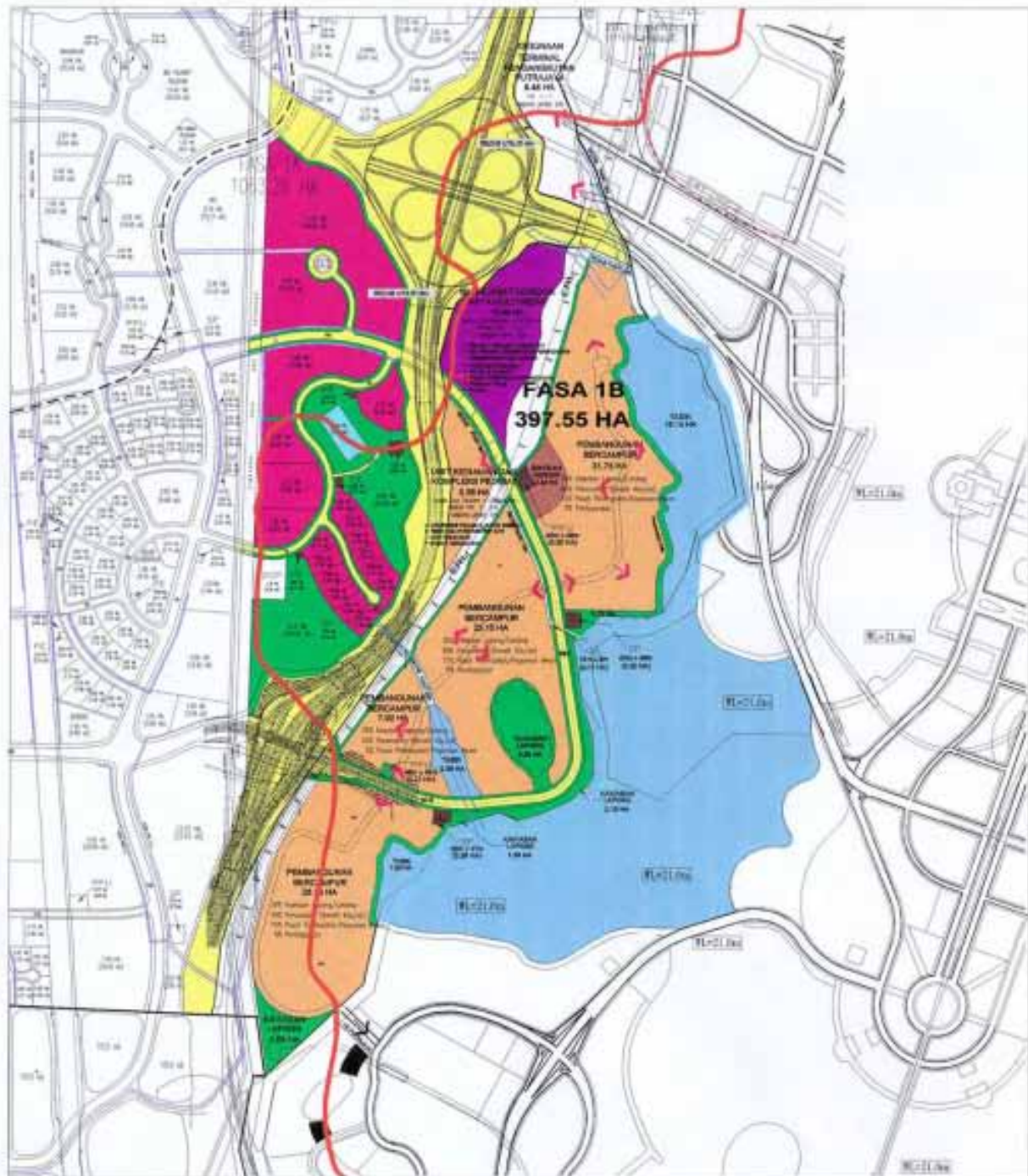
The Cyberjaya Flagship Development Zone (Phase 1B), also known as ‘Kawasan Persyarikatan’ in the Structure Plan of Putrajaya and part of Sepang District covers an area of 18,300 acres or 7,589 ha. The development in this area is governed by the policies described in the Structure Plan for the area. Only 607 acres (225 ha) of the total area lies within the Putrajaya Lake Catchment. The overall development concept of the area has to be in line with the planning concept for Putrajaya, i.e. development to create an ‘Intelligent City’ and a ‘City In A Garden’. All private and individual land owners in the vicinity of Cyberjaya are required to develop their land in accordance with the overall development concept. Figure 6.9 shows a plan of the Cyberjaya Flagship Development Zone phase 1B.

6.3.7.1 The Existing and Committed Development

(1) The concept of the Cyberjaya development emphasises the following characteristics:

- Intelligent City
- City In A Garden
- Neighbourhood Concept

**FIGURE 6.9
COMMITTED LANDUSE
CYBERJAYA**



LEGEND >

	ADMINISTRATION/OFFICE		ROAD RESERVE
	ENTERPRISE		LAKE CATCHMENT BOUNDARY
	MIXED DEVELOPMENT		
	OPEN SPACE/RECREATION		
	LAKE/POND		
	OTHERS		



TITLE >

CYBERJAYA LANDUSE

CATCHMENT DEVELOPMENT AND MANAGEMENT PLAN
FOR PUTRAJAYA LAKE

- Environmental Friendly
- Efficient Transportation System
- Effective Public Utility
- Green Belt Concept

(2) The land-use of this area are for housing, commercial, administration centre etc. with emphasis on open space, which is more than 30%. The breakdown of land-uses is shown in Table 6.5.

6.3.7.2 *Physical Characteristic*

The site is hilly towards the Putrajaya lake and ranges between 25 to 50 meter. There is also provision for 51 acres of Lake in the development, complete with gross pollutant traps.

6.3.7.3 *Site Potentials and Constraints*

(1) The site has been committed with low density mixed development, which is in line with the Putrajaya development and policies underlined in the Putrajaya and Sepang Structure Plan. The development principles of Cyberjaya in terms of environmental considerations are;

- Low density development, well landscaped features and environmentally-friendly,
- Development emphasis on free standing buildings,
- Energy saving, clean and pollutant free activities.

(2) The MSC guideline also stated that Cyberjaya should follow the world-class environmental standards and guideline, and only R&D activities are allowed. Industries are strictly prohibited.

Table 6.5 Existing and Committed Land-use for Cyberjaya

Landuse/Activities	Area (acre)	Percentage (%)
B. BUILDINGS		
- Offices	66.45	27.40
- Housing	121.45	50.08
- School	6.05	2.49
- Commercial	12.15	5.01
- Other Public Facilities	36.43	15.02
Total	242.53	39.96
B. GREEN AREAS		
- Open Space/Green	104.22	88.86
- Recreation	13.07	11.14
Total	117.29	19.32
D. WATER BODY		
- Lake	51.03	100.00
Total	51.03	8.40
D. INFRASTRUCTURE		
- Express Rail Link (ERL)	35.77	18.23
- Highway	81.85	41.72
- Roads & Drainage	48.22	24.58
- Others	30.35	15.47
Total	196.19	32.32
Total Lake Catchment Area	607.04	100.00

6.3.8 Sungai Merab Malay Reserve

The Sungai Merab Malay Reserve is located on the eastern side of Putrajaya (adjacent to Putrajaya housing development) at Kampung Tengah which covers only 89.60 acres of agriculture lands.

6.3.8.1 Existing and Committed Development

Currently, there is no development around this area. The existing land-use is rubber tree cultivation and 5 numbers of village houses.

6.3.8.2 Physical Characteristic

17 lots are affected within the catchment. The topography of this area is sloping down towards Precinct 15 of Taman Jati and Precinct 16 (Putrajaya). The highest point is about 100 feet.

6.3.8.3 *Site Potentials & Constraints*

Sungai Merab Malay Reserve is predominantly residential zones where smart homes and smart schools will be located as stated in the MSC guideline. This area will also be the test-bed for electronic innovations and information technology. All Malay Reserve, especially the Sg. Merab Village are deemed approved for enterprise, residential, commercial and social facilities development, as stated in the Structure Plan policy, Putrajaya and MSC guidelines. They are required to support the Putrajaya development and preserve it's environment.

6.3.9 *Universiti Tenaga Nasional (UNITEN)*

This area is located at the north-eastern edge of the lake catchment adjacent to West Country. The existing land-use is rubber tree cultivation. The area within the catchment is only 93.80 acres.

6.3.9.1 *Existing and Committed Development*

Currently there is a rubber tree estate with slopes of 5 – 20 degrees. UNITEN has been zoned as institutional with academic and R&D development.

6.3.9.2 *Physical Characteristic*

The topography of UNITEN is hilly and ranges between 70 to 80 meter and slopes to the western area. The dominant land use is agriculture.

6.3.9.3 *Site Potentials & Constraints*

The Structure Plan has zoned UNITEN under Sungai Merab, Bangi Institutional Area with green and low-density development. Therefore, UNITEN should be developed along the same concept as UPM, which is to preserve the greens within a low-density development.

As the institutional zone, UNITEN will be developed as a collaborative cluster of academic institutions and R&D Centre.

6.3.10 *Comments on the existing developments*

6.3.10.1 The following are the Consultants comments on the existing developments, based on the information compiled todate.

- The stakeholders in general follow the concept of the Putrajaya development, which emphasises the preservation of the green and environmental friendly environment.
- Some of the stakeholders are in the process of developing their land or are in the process of applying for development planning approval for land.
- Most of the highway network and rail link have been committed on the stakeholder land.

6.3.10.2 Generally, the existing land-use of the lake catchment is still under control and in line with the concept proposed by Putrajaya development and within the policies of the Structure Plan and existing Guidelines. However, expansion of development or future plans from the stakeholder especially MARDI, UPM, West Country and in the Sg. Merab Malay Reserve (others are committed) need to be taken into consideration. They are as follows;

UPM

- It's masterplan has indicated plans for the expansion for sports complexes, hospital, faculty complexes and flexible development zones.

MARDI

- To develop into an effective Research & Development Centre on agriculture, with farms and orchards complex.

TNB

- There are no proposed development for this area. It has been fully utilised and there is a buffer zone of green areas to cater for emergency events.

IOI

- This site has been fully committed with low-density development. The development is in line with the Putrajaya development concept.

West Country Berhad

- It has plans for low-density housing developments in the areas within the lake catchment.

Cyberjaya

- The areas within the Lake Catchment have been committed with mixed development. The development is in line with the overall concept of Putrajaya.

Sungai Merab

- The development of Malay Reserve areas is to be encouraged for housing. However, other developments such as commercial, recreation, golf course, tourism etc. have to be screened thoroughly to ensure the development concept for the Putrajaya and Sepang Structure Plan and to support the Putrajaya development and preserve its environment.

UNITEN

- The future development will be academic and R&D purposes as have been zoned in the development plan.

6.4 THE DEVELOPMENT STRATEGY AND CONCEPT

6.4.1 Introduction

6.4.1.1 The development strategy for the Putrajaya Lake Catchment is based on the concept of a harmonious relationship between Man and His Creator, Man and Man, Man and Technology, and Man and the Environment.

6.4.1.2 The development concept has taken into consideration all factors that has risen in the preparation of the development forms based on planning principles. Figure 6.10 shows the concept for the lake catchment development.

6.4.2 Development Component

6.4.2.1 Generally the development component for the lake catchment can be described as follows;

- Institutional Use
- Low Density Housing
- Park & recreation
- Farm & Orchards
- Lake/pond

**FIGURE 6.10
CONCEPT PLAN**

Institutional

- Academic Use
- Sport & Recreation
- R & D Centre
- Hospital
- Other Facilities

Buffer zone

- 30m Buffer Along The Utilities

Utilities

- TNB Station
- Buffer Zone

Low Density Housing

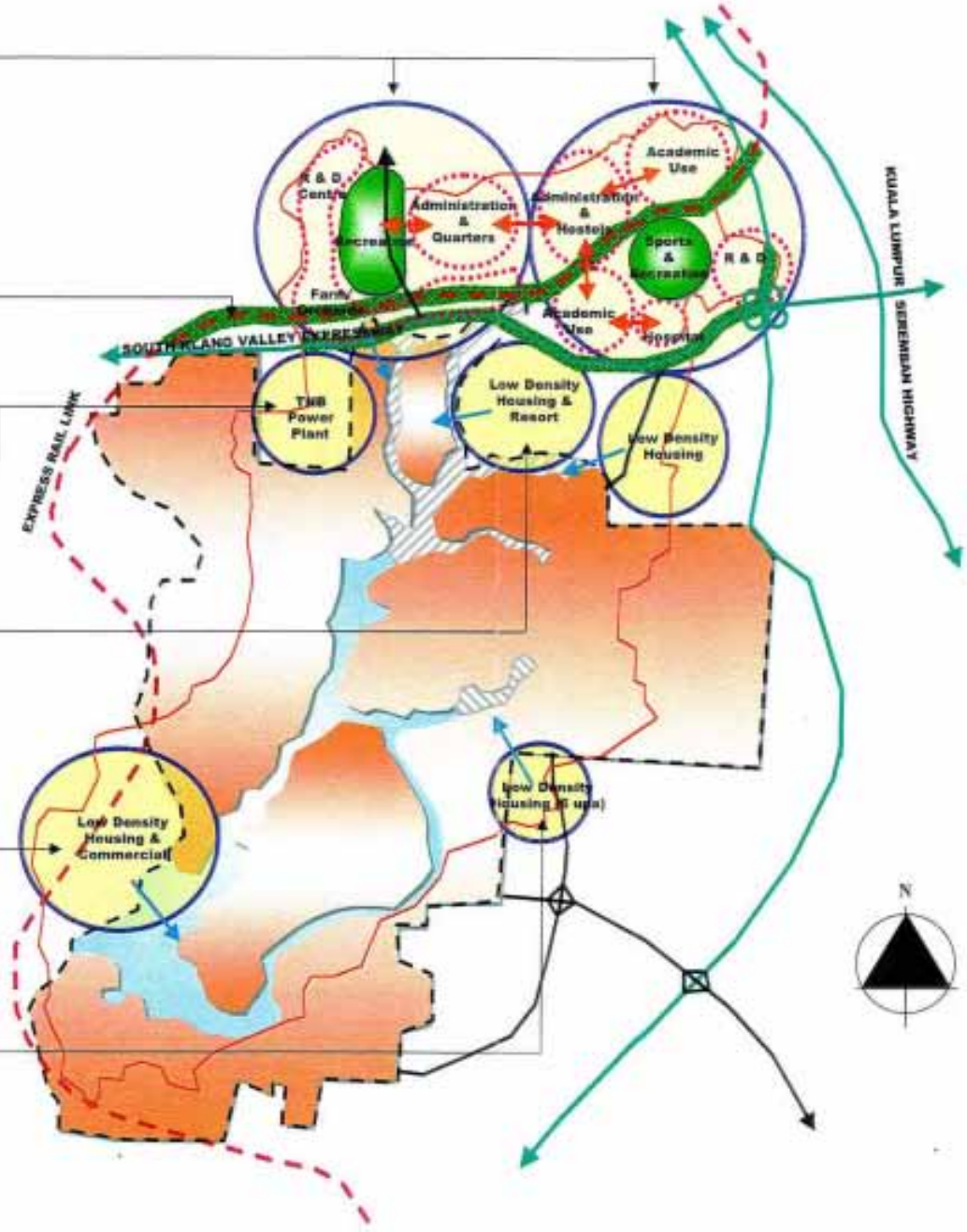
- Bungalow
- Semi-Detached
- Resort
- Golf Course
- Commercial








Mixed Development

- Housing
- Office
- Commercial
- Green & Recreation

Low Density Housing

- Low Density Housing (6 Unit Per Acre)



-  Inter Network Linkages
-  Water Discharge
-  Expressway
-  Express Rail Link
-  Road
-  Lake Catchment Boundary
-  Buffer Strip

6.4.2.2 *Institutional Use*

In line with the MSC and Putrajaya development, the lake catchment was proposed as a collaborative cluster of research institutions concentrating on IT research and learning within an R&D Centre. The development is to be concentrated to the North of the Lake Catchment.

6.4.2.3 *Low Density Housing*

Development with high-tech infrastructure and social facilities to create an excellent living environment with clean and pollutant free activities. The development also gives emphasis on well-landscaped features and is to be environmental-friendly.

6.4.2.4 *Park & Recreation*

In line with the objective to create and harmonise the development with the environment, parks and recreation areas have also been proposed e.g. cyber park, forest park, golf course and sport complexes.

6.4.2.5 *Farms & Orchard*

The development of MARDI will be based on the concept of green lung so as to support the development of Putrajaya. The development will be focussed on introducing to the public a love for nature. The emphasis of the developments will be on education, upgrading of the environment, public recreation (forest park) and encouragement of agro-based entrepreneur.

6.4.2.6 *Lake/pond*

Development within the lake catchment areas will be based on these water bodies which are the essential elements that will create the natural environment in the area. It will also be used for water recreational activities, e.g. canoeing, fishing, boating etc.

6.4.3 Rationale & Justification

6.4.3.1 The factors that form the development strategy and concept are as follows;

- The Structure Plan policies states that low-density development which is in line with the Putrajaya development concepts are to be carried out. The Plan also emphasizes the need to preserve the environment and create a green landscape. The pertinent policies are;
 - Development without negative impact to the environment.
 - Preservation of forest reserve and water catchment areas.
 - Recreation and open space reservation in future developments.
 - Preservation of water sources.
 - Landscaped utility reserves.
- Potential land that can be developed is about 2,098 acres (850 ha) (48%), which gives space to various scales of development.
- Natural assets e.g. hills, rivers, ponds and agriculture can be created to achieve the “World Class Environment”.
- Infrastructure Plans, e.g. Express Rail Link (ERL), South Klang Valley Expressway (SKVE) and main roads that pass through the study area can be used to encourage and facilitate future development.
- Existing developments, e.g. the Institutional Zone, R&D and green areas have given a unique identity to the area which are in line with the Putrajaya development.

6.5 THE PROPOSED LAND-USE MASTERPLAN

6.5.1 Introduction

6.5.1.1 The integrated land-use masterplan for the catchment is described under the analysis for the zoning plan below. The analysis is based on the results from the various studies, such as existing and committed development, physical characteristic, environmental or sensitive area, drainage and geology. Furthermore, the Putrajaya and MSC guidelines and the Structure Plan policies have also been incorporated to form the Lake catchment masterplan.

6.5.1.2 The Lake catchment masterplan gives emphasis on integrated and sustainable development. It is shown in Figure 6.11 and the land-use tabulated in Table 6.6. Basically the future development in the lake catchment will be concentrated in the areas of UPM, MARDI and in the Sungai Merab Malay Reserve. The other stakeholders have already committed their developments and there is only a need to monitor their development implementations.

6.5.2 Zoning Plan

6.5.2.1 UPM

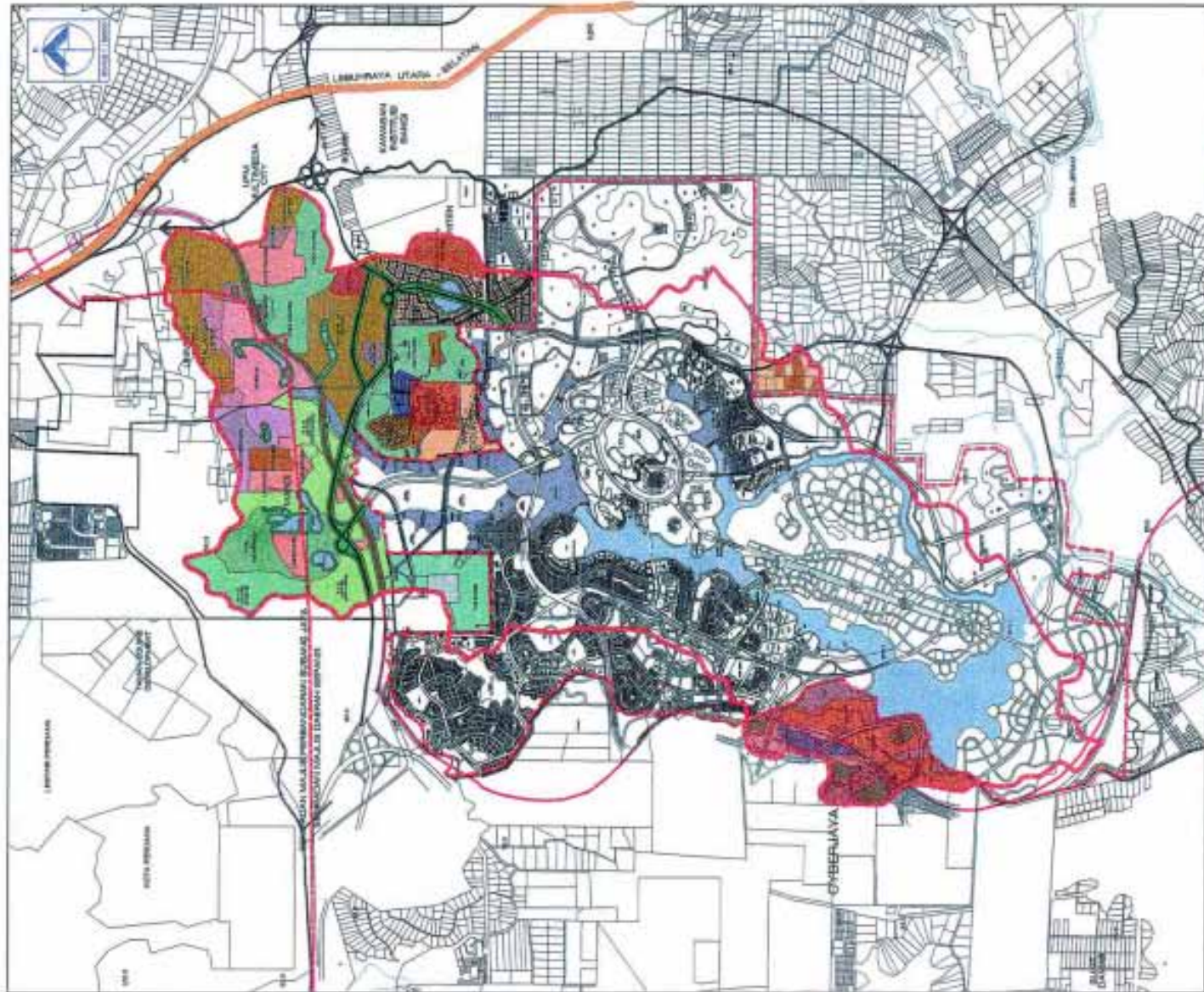
(1) UPM is zoned under Institutional with ample green area and low density mixed development. Therefore UPM can be developed in a manner to preserve the greens with low-density development.

(2) It is proposed that UPM will serve as the R&D Centre and will be a collaborative cluster of academic institutions which offer courses on information technology and corporate R&D centres as shown in Figure 6.12. UPM will undertake research and development oriented industries which require close co-operation with academic and research institution equipped with facilities for laboratory testing, R&D, and skill training centres. An example of such collaboration is the MTDC-UPM Incubation Centre. The existing pond/lake can also be upgraded as a recreational centre for public use, as illustrated in Illustration 6.1.

TABLE 6.6 : PROPOSED LANDUSE MASTERPLAN FOR PUTRAJAYA LAKE CATCHMENT (ACRE)

LAKE CATCHMENT AREA (Acre)	UPM	%	MARDI	%	IOI	%	TNB	%	WEST COUNTRY	%	CYBER JAYA	%	SUNGAI MERAB	%	UNITEN	%	TOTAL	%
A. BUILDINGS																		
Administration/Offices	-	-	151.38	57.48	-	-	-	-	-	-	66.45	27.40	-	-	-	-	217.83	11.84
Hostels/College	213.68	29.52	-	-	-	-	-	-	-	-	-	-	-	-	-	-	213.68	11.62
Housing/Quarters	-	-	19.30	7.33	132.20	82.14	-	-	236.26	100.00	121.45	50.00	89.60	100.00	-	-	598.81	32.56
Commercial	-	-	-	-	17.46	10.86	-	-	-	-	12.15	5.01	-	-	-	-	29.61	1.61
Academic/R&D	312.89	43.23	-	-	-	-	-	-	-	-	-	-	-	-	93.80	100.00	406.69	22.11
Power Station	-	-	-	-	-	-	28.95	100.00	-	-	-	-	-	-	-	-	28.95	1.57
Facilities	197.25	27.25	92.68	35.19	11.27	7.00	-	-	-	-	42.48	15.02	-	-	-	-	343.68	18.69
TOTAL	723.82	50.94	263.36	22.93	160.93	30.77	28.95	12.98	236.26	61.96	242.53	39.96	89.60	100.00	93.80	100.00	1,839.25	41.97
B. GREEN AREAS																		
Open Space/Field Recreation	189.66	49.28	183.49	26.82	5.82	2.61	-	-	17.66	-	110.06	100.00	-	-	-	-	506.69	31.16
Golf Course	186.51	48.46	-	-	216.90	97.39	-	-	-	-	-	-	-	-	-	-	403.41	24.81
Farms	-	-	141.21	20.64	-	-	-	-	-	-	-	-	-	-	-	-	141.21	8.68
Orchards	-	-	354.96	51.88	-	-	-	-	-	-	-	-	-	-	-	-	354.96	21.83
Buffer Zone	8.67	2.25	4.51	0.66	-	-	194.03	100.00	5.34	23.22	7.23	-	-	-	-	-	219.78	13.52
TOTAL	384.84	27.09	684.17	59.57	222.72	42.59	194.03	87.02	23.00	6.03	117.29	19.32	-	-	-	-	1,626.05	37.11
C. WATER BODIES																		
Pond/Lake	24.18	100.00	56.02	81.78	7.00	14.29	-	-	18.30	100.00	51.03	100.00	-	-	-	-	156.53	76.91
Wetland	34.51	-	12.48	-	-	85.71	-	-	-	-	-	-	-	-	-	-	46.99	23.09
TOTAL	58.69	4.13	68.50	5.96	7.00	21.41	-	-	18.30	4.80	51.03	8.40	-	-	-	-	203.52	4.64
D. INFRASTRUCTURE																		
Roads/Drainage	61.57	24.29	53.32	40.24	24.47	89.63	-	-	55.27	53.26	48.22	24.58	-	-	-	-	242.85	34.05
Express Rail Link	73.86	29.13	48.32	36.47	-	-	-	-	-	-	35.77	18.23	-	-	-	-	157.95	22.14
Highway	118.08	46.58	30.85	23.28	-	-	-	-	47.20	45.49	81.85	41.72	-	-	-	-	277.98	38.97
Others	-	-	-	-	2.83	10.37	-	-	1.30	1.25	30.35	15.47	-	-	-	-	34.48	4.83
TOTAL	253.51	17.84	132.49	11.54	27.30	5.23	-	-	103.77	27.21	196.19	32.32	-	-	-	-	713.26	16.28
GRAND TOTAL	1,420.86	100.00	1,148.52	100.00	417.95	100.00	222.98	100.00	381.33	100.00	607.04	100.00	89.60	100.00	93.80	100.00	4,382.08	100.00

**FIGURE 6.11
PROPOSED INTEGRATED
LANDUSE MASTERPLAN**



NOUR	WTD	PROPOSED INTEGRATED LANDUSE MASTERPLAN					
CATCHMENT DEVELOPMENT AND MANAGEMENT PLAN FOR PUTRAJAYA LAKE							
RESIDENTIAL							
BUILDING	EXISTING	ACRE	CONVERTED ACRE	ACRE	PERCENT	ACRE	PERCENT
APARTMENT	10.00	10.00	0.00	0.00	0.00	0.00	0.00
SEMI-DETACHED	1.00	1.00	0.00	0.00	0.00	0.00	0.00
TOWNHOUSE	10.00	10.00	0.00	0.00	0.00	0.00	0.00
INDUSTRIAL	10.00	10.00	0.00	0.00	0.00	0.00	0.00
TOTAL	30.00	30.00	0.00	0.00	0.00	0.00	0.00
COMMERCIAL							
OFFICE	10.00	10.00	0.00	0.00	0.00	0.00	0.00
RETAIL	10.00	10.00	0.00	0.00	0.00	0.00	0.00
INDUSTRIAL	10.00	10.00	0.00	0.00	0.00	0.00	0.00
TOTAL	30.00	30.00	0.00	0.00	0.00	0.00	0.00
INDUSTRIAL							
INDUSTRIAL	10.00	10.00	0.00	0.00	0.00	0.00	0.00
WATER	10.00	10.00	0.00	0.00	0.00	0.00	0.00
TOTAL	20.00	20.00	0.00	0.00	0.00	0.00	0.00
GREEN SPACES							
LANDSCAPE	10.00	10.00	0.00	0.00	0.00	0.00	0.00
WATER	10.00	10.00	0.00	0.00	0.00	0.00	0.00
TOTAL	20.00	20.00	0.00	0.00	0.00	0.00	0.00
WATER							
WATER	10.00	10.00	0.00	0.00	0.00	0.00	0.00
TOTAL	10.00	10.00	0.00	0.00	0.00	0.00	0.00
GRAND TOTAL							
EXISTING	ACRE	CONVERTED	ACRE	TOTAL	PERCENT	ACRE	PERCENT
PUTRAJAYA	10000	10000	0	10000	100.00	10000	100.00
SURROUNDING PUTRAJAYA	10000	10000	0	10000	100.00	10000	100.00
TOTAL LAND CATCHMENT	20000	20000	0	20000	100.00	20000	100.00

**FIGURE 6.12
UNIVERSITI PUTRA MALAYSIA
LANDUSE ZONING**

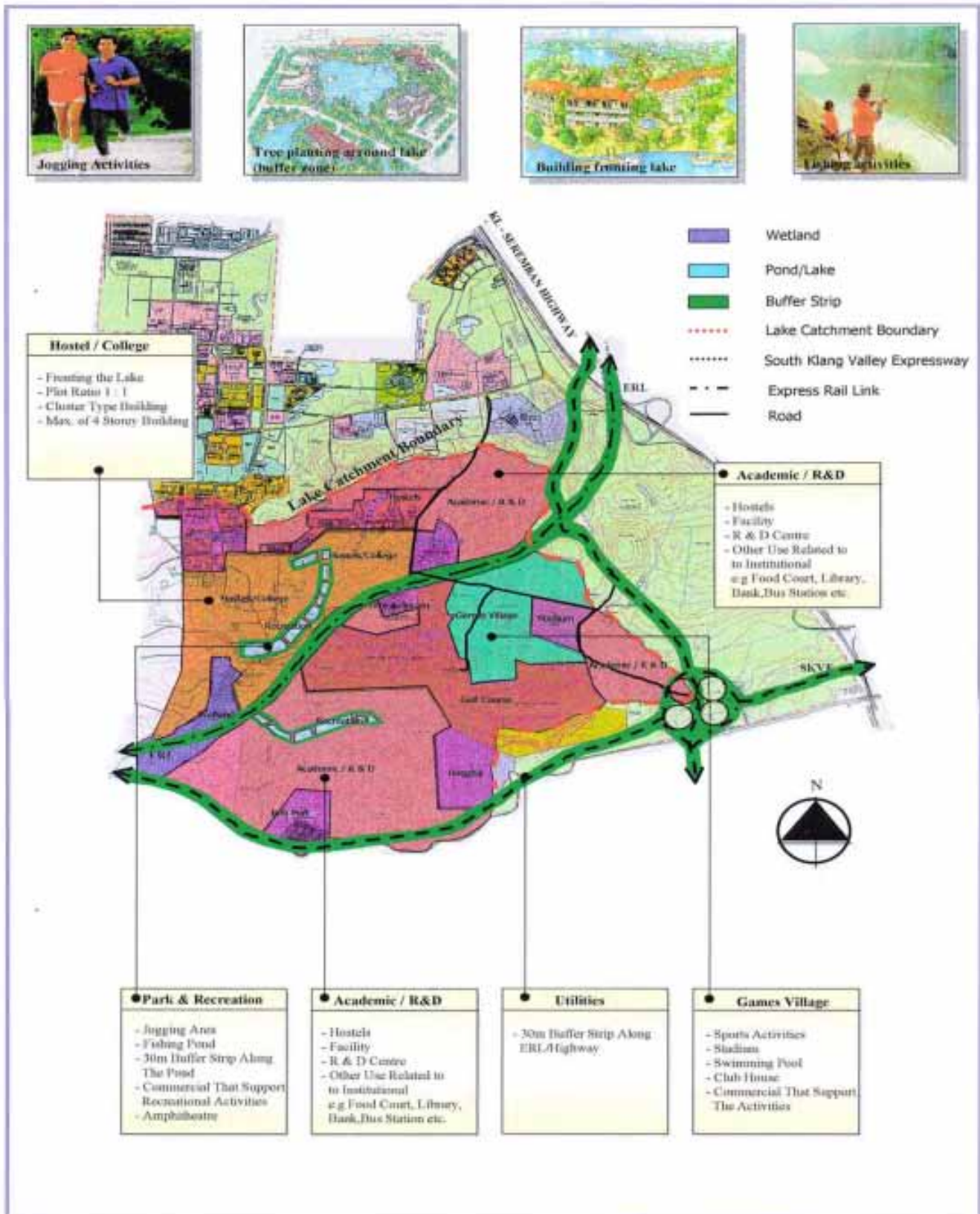


ILLUSTRATION 6.1 :
UPM RECREATION
LAKE & PARK



• FOOD COURT

- As one of supporting activities of recreation
- To encourage social interaction among the residents

• LABORATORIES

• HOSTELS

• JETTY

• UPM POND/LAKE

- to be preserve as the inter linkages of water bodies in the lake catchment

• BUFFER ZONE

- Can be created as linear park
- provide continuous green
- with pocket greens

• EXPRESS RAIL LINK

• FISHING ACTIVITIES

- can be created to relaxing mind
- Buffer zone to screening noise of ERL and etc.

**• BOATING/
CANOING**

• JOGGING TRACK & PEDESTRIAN WALKWAY

- The approach of UPM lake recreational is towards the community planning and responsive environment
- Will be develop as green environment with intelligent development and natural features

6.5.2.2 *MARDI*

MARDI will also be zoned under R&D centres with green lung concept for agriculture with complexes of farms, orchards complex for agricultural education and experimental, public forest park purposes as shown in Figure 6.13. Illustration 6.2 also shows the types of activities at the forest park..

6.5.2.3 *Sungai Merab*

The section of the Sungai Merab Malay Reserve areas that lies within the catchment are proposed for enterprise, residential, commercial and social facilities development to support the Putrajaya development and preserve the environment with minimal pollution.

6.5.3 Use Class Order

The development in the lake catchment should also be controlled under the use class order listed in Table 6.7.

6.6 LAND-USE CONTROL GUIDELINES

6.6.1 Introduction

The land-use control guidelines are as follows;

- Preservation and Conservation of Environmentally Sensitive Areas
- Protection of rare, endemic and endangered species
- Pollution Prevention and Minimisation
- Water Conservation

6.6.2 Existing Guidelines

The following generic guidelines should be adopted for any development proposals within the catchment, namely;

- The Environmental Quality Act, 1974 and all regulations made thereunder
- Guidelines on Environmental Impact Assessment: Procedure and Requirement in Malaysia, Department of Environment (1995)
- 'Garis Panduan Konsep Pembangunan berhadapan Sungai', Jabatan pengairan dan Saliran (1995)
- Guidelines for Prevention and Control of Soil Erosion and Siltation, Final Draft, Department of Environment (1996)

**FIGURE 6.13
MARDI
LANDUSE ZONING**

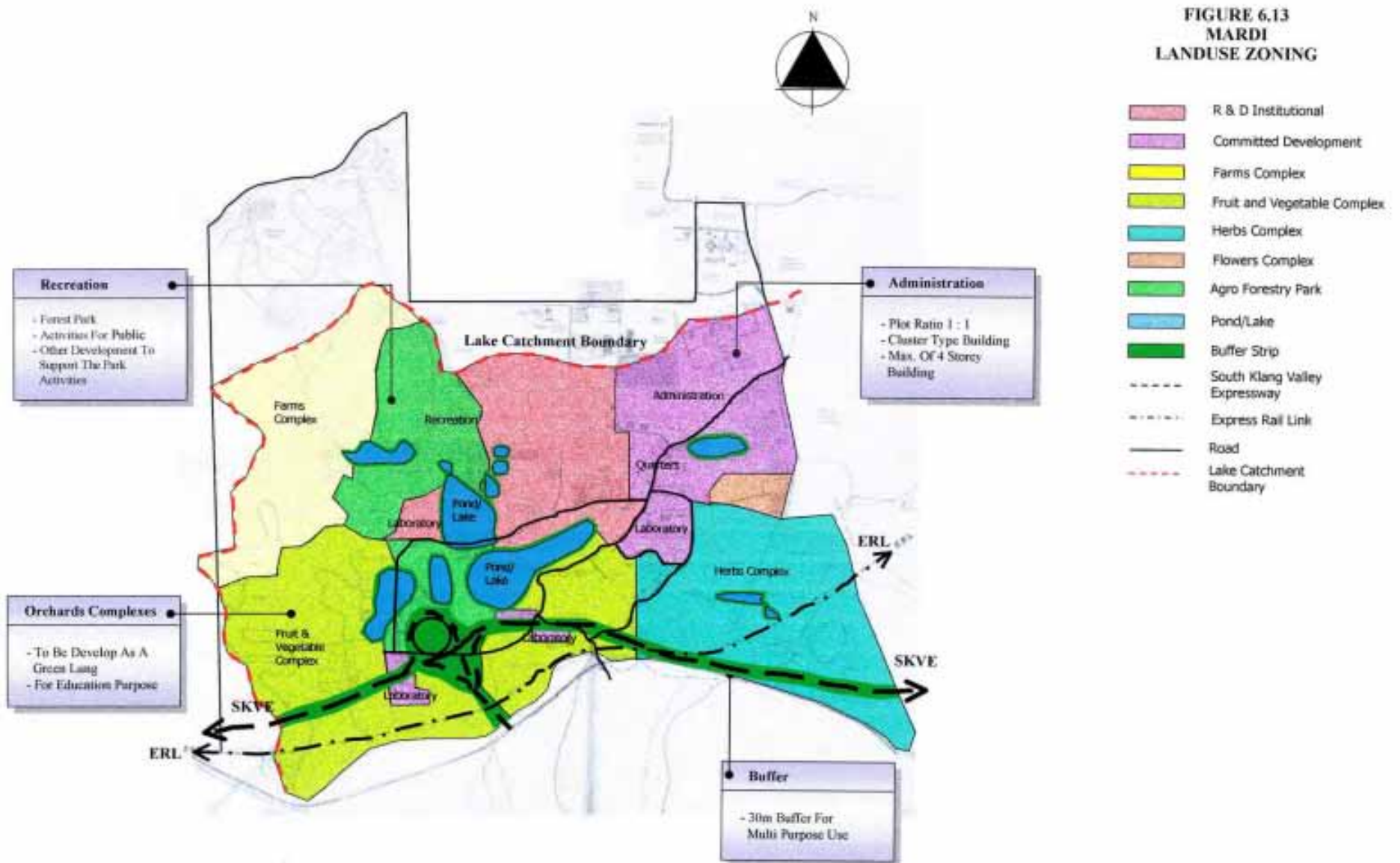


ILLUSTRATION 6.2 :
MARDI FOREST

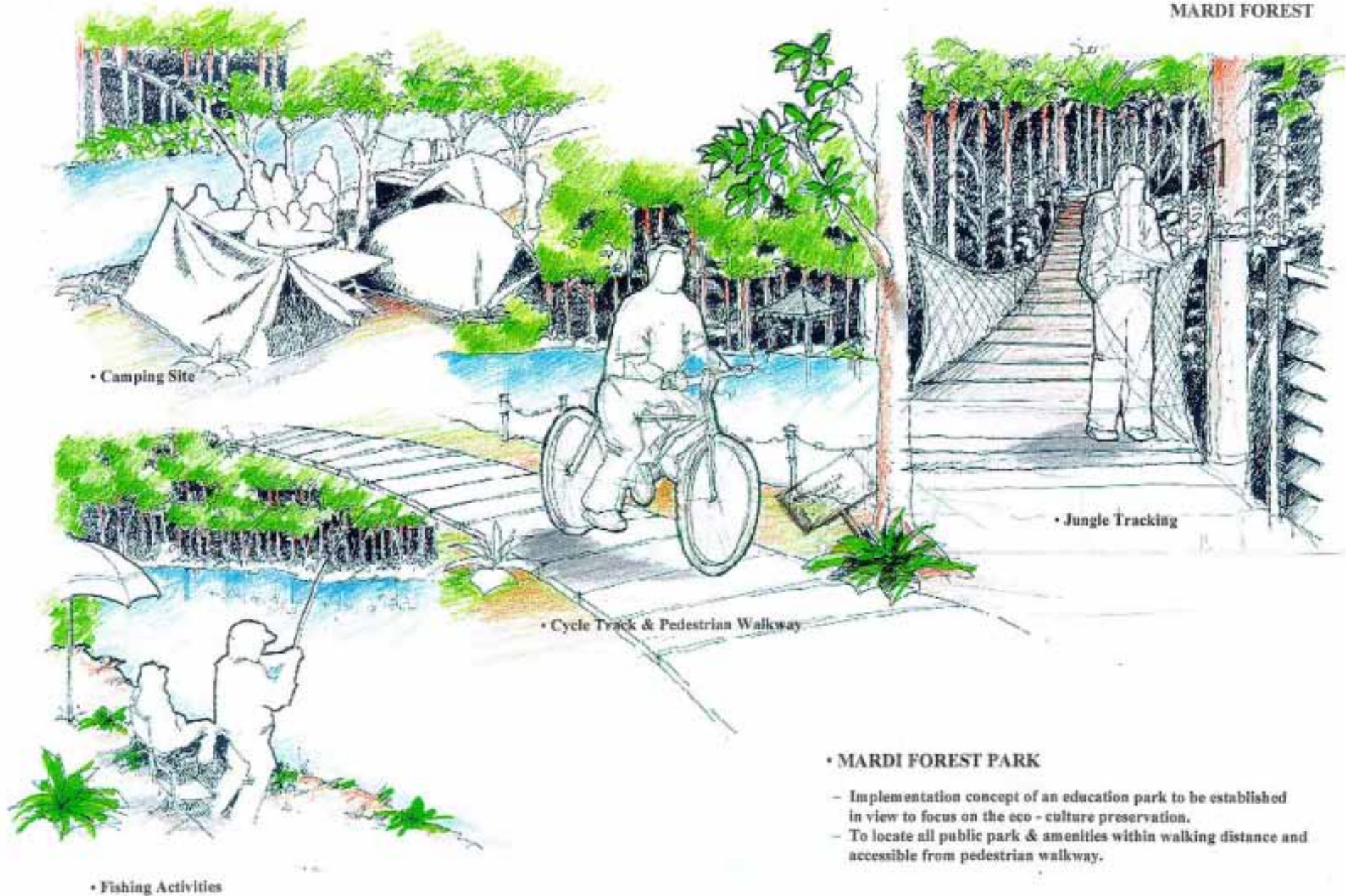


TABLE 6.7: LAKE CATCHMENT LANDUSE MASTERPLAN – USE CLASS ORDER

LAKE CATCHMENT AREA (PLOT)	PERMITTED USE	PERMITTED WITH CONDITION		NON PERMITTED USE
		UPM	INSTITUTIONAL	
Institutional Centre Total Area: 1,420.86 acre	<ul style="list-style-type: none"> • Hostels/College • Faculty • Administration Centre • R&D Centre • Farms & Orchards • Open Space/Feild • Library • Laboratory 	<ul style="list-style-type: none"> • Hospital • Staff Quarters • Supporting Commercial - Bank, Shop, Food court, clinic etc. • Mosque • Pedestrian walk • Buffer Zone • Sewage Treatment Plant • Road/Drainage • Highway/ERL 	<ul style="list-style-type: none"> • To comply with Guidelines - Planning Standard, Lake Catctment, Putrajaya, MSC Guidelines and Sg. Merab Local Plan. • Enhance and introduce riparian buffer strips (non-point BMP) • Medical/laboratory wastes should be discharged out of the catchment • Shoreline & riparian buffer are planned along drainage lines & the lake. • Install mitigating measures to prevent pollutant input from the roads crossing the wetland • Fertilizer & pesticide use is controlled and monitored. • Stream flow to be preserve • Turfing of cleared land to carried out • EMP programme must be implemented - soil erosion management programme to be included 	<ul style="list-style-type: none"> • Industry • Land earthwork clearing more than 15% of catchment at anyone time • Development with pollution excess fertilizers, herbicides, and insecticides from agricultural lands and parks - bacteria and nutrients from livestock, wildlife, pet wastes and sewerage system
Research Centre Total Area: 1,148.52 acre	<ul style="list-style-type: none"> • Administration Office • R&D Centre • Laboratory • Store • Farms & Orchards • Nursery 	<ul style="list-style-type: none"> • Staff Quarters • Hostels • Supporting Commercial - Canteen, Food court, etc. • Buffer zone • Recreation/Open Space • Lake/pond • Road/Drainage • Highway/ERL 	<ul style="list-style-type: none"> • To comply with Guidelines - Planning Standard, Lake Catctment, Putrajaya, MSC Guidelines and Sg. Merab Local Plan. • Enhance and introduce riparian buffer strips (non-point BMP) • Utilise constructed ponds to retain drainage and stream flows • Laboratory wastes should be discharged out of the catchment • Shoreline & riparian buffer are planned along drainage lines & the lake. • Install mitigating measures to prevent pollutant input from the roads crossing the wetland • Stream flow to be preserve • Turfing of cleared land to carried out • EMP programme must be implemented - soil erosion management programme to be included 	<ul style="list-style-type: none"> • Industry • Land earthwork clearing more than 15% of catchment at anyone time • Development with pollution excess fertilizers, herbicides, and insecticides from agricultural lands and parks • bacteria and nutrients from livestock, wildlife, pet wastes and sewerage system

LAKE CATCHMENT AREA (PLOT)	PERMITTED USE	PERMITTED WITH CONDITION		NON PERMITTED USE
IOI	HOUSING & RECREATION	Activities	Conditions	
Country Homes & Golf Course Total Area: 417.95 acre	<ul style="list-style-type: none"> • Low Density Housing - Bungalow lots • Sports and recreations • Open Space/Feild 	<ul style="list-style-type: none"> • Neighbourhood Commercial - Club House - Nursery Centre - Health Club - Shops - Clinic • Golf Course • Road/Drainage 	<ul style="list-style-type: none"> • To comply with Guidelines - Planning Standard, Lake Catctment, Putrajaya, MSC Guidelines and Sg. Merab Local Plan. • Low Medium Density Development • Enhance and introduce riparian buffer strips (non-point BMP) • Development should occur in stages, planned to extend over 8 to 10 years to allow for monitoring and re-evaluation of impacts. • Providing Flood Detention Pond • Fertilizer & pesticide use is controlled and monitored • Stream flow to be preserved • Turfing of cleared land to carried out • EMP programme must be implemented - soil erosion management programme to be included 	<ul style="list-style-type: none"> • Industry • Development with pollution - sediment from improperly managed construction sites and eroding stream banks. • Development on slope with more than 20% (except recreations)
TNB	FACILITIES	Activities	Conditions	
Power Station Total Area: 222.98 acre	<ul style="list-style-type: none"> • Power Plant • Green Network - Reserve for electric line - Buffer Zone 	<ul style="list-style-type: none"> • Recreation • TNB Facilities • Open Space/Feild 	<ul style="list-style-type: none"> • To comply with Guidelines - Planning Standard, Lake Catctment, Putrajaya, MSC Guidelines and Sg. Merab Local Plan. • Enhance and introduce riparian buffer strips (non-point BMP) • Install mitigating measures to prevent pollutant input from the roads crossing the wetland 	<ul style="list-style-type: none"> • Any development accept TNB use
WEST COUNTRY BHD.	HOUSING	Activities	Conditions	
Housing Total Area: 381.33 acre	<ul style="list-style-type: none"> • Low Density Housing - Bungalow lots • Sports and recreations • 	<ul style="list-style-type: none"> • Neighbourhood Commercial - Shops, Clinic etc. • Institutional • Lake/pond • Sewage Treatment Plant • Road/Drainage • Highway 	<ul style="list-style-type: none"> • To comply with Guidelines – Planning Standard, Lake Catctment, Putrajaya, MSC Guidelines and Sg. Merab Local Plan. • Enhance and introduce riparian buffer strips (non-point BMP) • Development should occur in stages, planned to extend over 8 to 10 years to allow for monitoring • Providing Flood Detention Pond • Fertilizer & pesticide use is controlled and monitored • Stream flow to be preserved • Turfing of cleared land to carried out • EMP programme must be implemented - soil erosion management programme to be included 	<ul style="list-style-type: none"> • Industry • Development with pollution - sediment from improperly managed construction sites and eroding stream banks. • Development on slope with more than 20% (accept recreations)

LAKE CATCHMENT AREA (PLOT)	PERMITTED USE	PERMITTED WITH CONDITION		NON PERMITTED USE
CYBERJAYA	HOUSING & OFFICES	Activities	Conditions	
Mixed Housing & Offices Total Area: 607.04 acre	<ul style="list-style-type: none"> • Low & Medium Density Housing • Commercial - shops, clinic, bank, food court etc. • Offices • Open Space/Feild • 	<ul style="list-style-type: none"> • Institutional • Commercial • Public facilities • Recreation • Lake/pond • Sewage Treatment Plant • Road/Drainage • Highway/ERL 	<ul style="list-style-type: none"> • To comply with Guidelines – Planning Standard, Lake Catctment, Putrajaya, MSC Guidelines and Sg. Merab Local Plan. • Enhance and introduce riparian buffer strips (non-point BMP) • Development should occur in stages, planned to extend over 8 to 10 years to allow for monitoring and re-evaluation of impacts. • Providing Flood Detention Pond • Fertilizer & pesticide use is controlled and monitored • Stream flow to be preserved • Turfing of cleared land to carried out • EMP programme must be implemented - soil erosion management programme to be included 	<ul style="list-style-type: none"> • Industry • Development with pollution - sediment from improperly managed construction sites and eroding stream banks. • Development on slope with more than 20% (accept recreations)
UNITEN	INSTITUTIONAL	Activities	Conditions	
Institutional Centre Total Area: 93.80 acre	<ul style="list-style-type: none"> • Hostels/College • Faculty • Administration Centre • R&D Centre • Farms & Orchards • Open Space/Feild • Library • Laboratory 	<ul style="list-style-type: none"> • Staff Quarters • Supporting Commercial - Bank, Shop, Food court, clinic etc. • Mosque • Pedestrian walk • Buffer Zone • Sewage Treatment Plant • Road/Drainage • Highway/ERL 	<ul style="list-style-type: none"> • To comply with Guidelines – Planning Standard, Lake Catctment, Putrajaya, MSC Guidelines and Sg. Merab Local Plan. • Enhance and introduce riparian buffer strips (non-point BMP) • Medical/laboratory wastes should be discharged out of the catchment • Development should occur in stages, planned to extend over 8 to 10 years to allow for monitoring and re-evaluation of impacts. • Install mitigating measuresss to prevent pollutant input from the roads crossing the wetland • Fertilizer & pesticide use is controlled and monitored • Stream flow to be preserved • Turfing of cleared land to be carried out • EMP programme must be implemented - soil erosion management programme to be included 	<ul style="list-style-type: none"> • Industry • Land earthwork clearing more than 15% of catchment at anyone time • Development with pollution - excess fertilizers, herbicides, and insecticides from agricultural lands and parks - bacteria and nutrients from livestock, wildlife, pet wastes and sewerage system

LAKE CATCHMENT AREA (PLOT)	PERMITTED USE	PERMITTED WITH CONDITION		NON PERMITTED USE
SUNGAI MERAB VILLAGE	HOUSING	Activities	Conditions	
Housing Total Area: 89.60 acre	<ul style="list-style-type: none"> • Low Density Housing - Bungalow lots - Cluster - Semi Detached 	<ul style="list-style-type: none"> • Neighbourhood Commercial - Local Shopping Centre • Enterprise Office • Research Centre/Institutional • Small/medium Enterprise related to IT • Open Space & Recreation • Public Facilities • Golf Course • Tourism • Lake/pond • Sewage Treatment Plant • Road/drainage 	<ul style="list-style-type: none"> • To comply with Guidelines - Planning Standard, Lake Catchment, Putrajaya, MSC Guidelines and Sg. Merab Local Plan. • Structure which are complimentary to recreational activities and environment • Enhance and introduce riparian buffer strips (non-point BMP) • Development should occur in stages, planned to extend over 8 to 10 years to allow for monitoring and re-evaluation of impacts. • Providing Flood Detention Pond • Fertilizer & pesticide use is controlled and monitored • Stream flow to be preserved • Turfing of cleared land to be carried out • EMP programme must be implemented - soil erosion management programme to be included 	<ul style="list-style-type: none"> • Industry • Development with pollution - sediment from improperly managed construction sites and eroding stream banks. • Development on slope with more than 20% (accept recreations)

Note;

Non Point BMP - Non Point Source of Best Management Practise (as described in Chapter 2.5)
 Detail 'Conditions' can be refer in Chapter 2.5 (Assesment of pollutant impact to Putrajaya Lake System)

- Environmental Requirement: A guide For Investors, Department of Environment (1994)
- ‘Garis Panduan kawasan Kolam takungan Sebagai Sebahagian tanah Lapang’, JPBD (1997)
- Guideline on Development Proposal Report, JPBD (1996)

6.6.3 Lake Catchment Guidelines

6.6.3.1 Generic Guidelines

The design concept of the lake catchment should observe the following general design guidelines;

1. Urban Design

- Creating design characteristics and building types that are compatible and flexible to the needs of a ‘high tech’ environment, varied life styles and affordability of the users.
- Creating networks of water bodies, green open spaces, public squares, pedestrian walkways and cycle paths as a basic concept in planning.
- Taking into account the natural topography of the area and blending this with the man-made elements in order to preserve the natural environment and to create attractive viewing points or vistas, serial vision, landmarks, balanced and harmonious skyline, etc.
- Creating urban design elements such as boulevards, landmarks, vistas, silhouettes, walkways, serial visions, public open spaces/squares, nodes, courtyards, theme parks, pedestrian malls, etc.
- Creating harmonious linkages between zones and other planned land-use components/activities.
- Promoting medium and low density developments with low rise buildings (except buildings which are planned as landmarks, subject to site development standards).
- Promoting characteristics of beauty, convenience, harmony, health and safety through combinations of land-use components and activities that are compatible and balanced in scale.
- Consists of elements of flexibility and sustainability to cater for the current and future needs without undermining the original goal and design concept of development.

- Orientation and design of buildings which optimise views or use of water bodies and parks, privacy considerations and design art of adjacent buildings. This is illustrated in Illustration 6.3, 6.4 & 6.5.
- Creation of balanced and attractive building skylines which harmonise with the surrounding natural physical features such as hills, water bodies and parks.

2. *Housing*

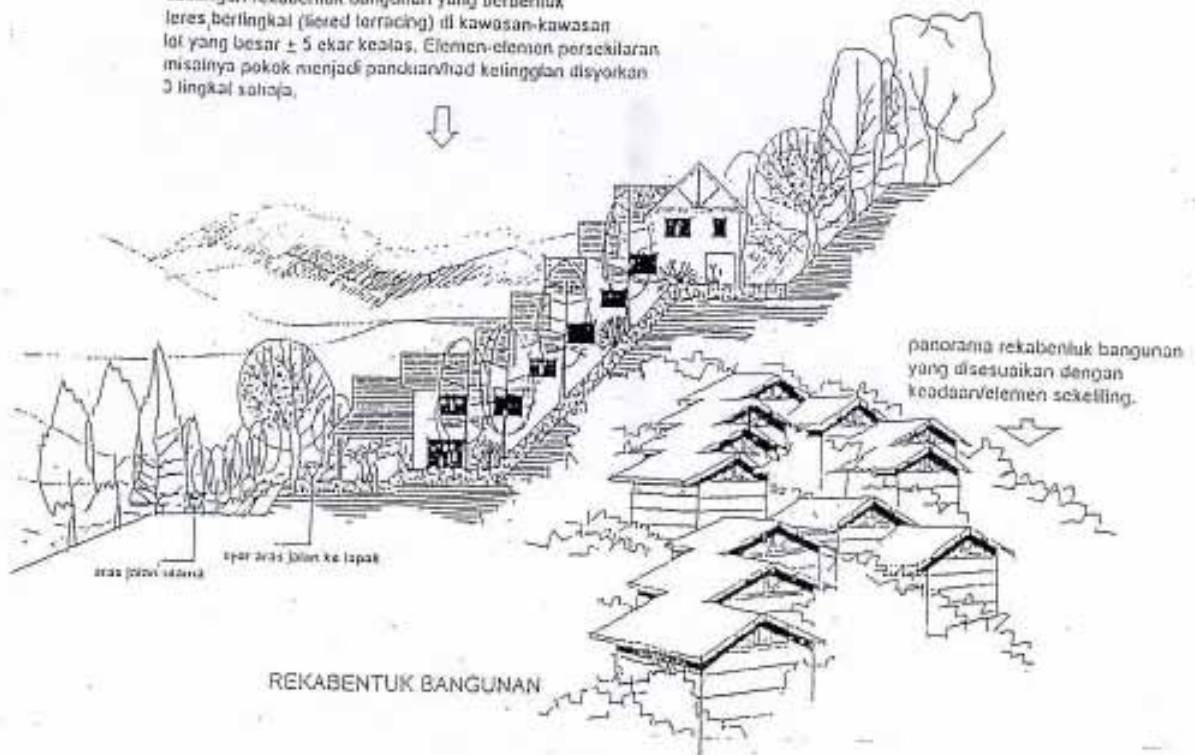
- Residential neighbourhoods shall be based on a residential park concept, and should represent a diverse and user-friendly dwelling types and styles
- Each residential neighbourhood shall be self sufficient in terms of provision of amenities, open space and retail activities as well as having the characteristics of a neighbourly atmosphere.
- Residential developments shall be in harmony with the site conditions, conform to the natural contours of the land and adapt to the surrounding terrain.
- Residential developments shall be designed based on the cluster design to allow for the utilisation of best building sites while preserving environmentally sensitive areas. Monotonous barrack-like layout is not encouraged.
- The orientation of buildings will have to be adapted to the natural vistas of the site to take advantage of the most potential and attractive natural view, sunlight and prevailing breezes.
- Housing development in hill areas would have to observe and abide with the guidelines on Natural Topography Preservation in Physical Planning and Development.

3. *Environment*

- Enhancement of open spaces, improving ecological functions in terms of biodiversity, wildlife habitats, urban forest and increasing total biomass to act as pollution sinks.
- Priority and greater percentage for public transport, efficient modal integration and maximum use of non-polluting forms of transport, creating more cycling paths and pedestrian-priority areas.

ILLUSTRATION 6.3 : BUILDING OREINTATION AND DESIGN

cadangan rekabentuk bangunan yang berbentuk leres, berlingkal (tered terracing) di kawasan-kawasan lot yang besar ± 5 ekar keatas. Elemen-elemen persekitaran misalnya pokok menjadi panduan/had ketinggian diayarkan 3 tingkat sahaja.



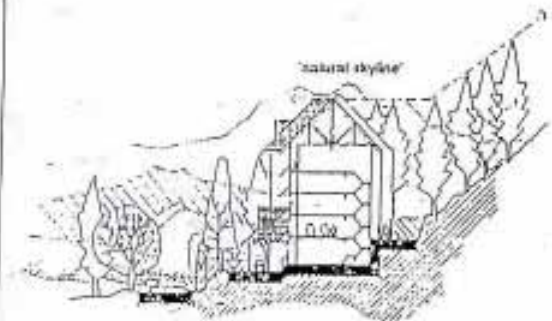
A. cadangan bangunan di lereng bukit yang curam, diayarkan kerja-kaji tanah dihadkan dengan mencatangkan rekabentuk bangunan, leres berlingkal (tered terracing) dan ketinggian bangunan yang diayarkan antara 3 hingga 5 tingkat sahaja. Ketinggian bangunan ini disesuaikan dengan elemen persekitaran bagi mengekalkan 'natural skyline'.



B. cadangan bangunan di lereng bukit yang curam, diayarkan kerja tanah dihadkan dan mencatangkan rekabentuk bangunan 2 hingga 3 tingkat atas jalan dan 1 hingga 2 tingkat bawah area jalan, ketinggian bangunan diayarkan 5 hingga 6 tingkat. Bangunan masih disesuaikan dengan elemen persekitaran untuk menjaga 'natural skyline' yang indah.



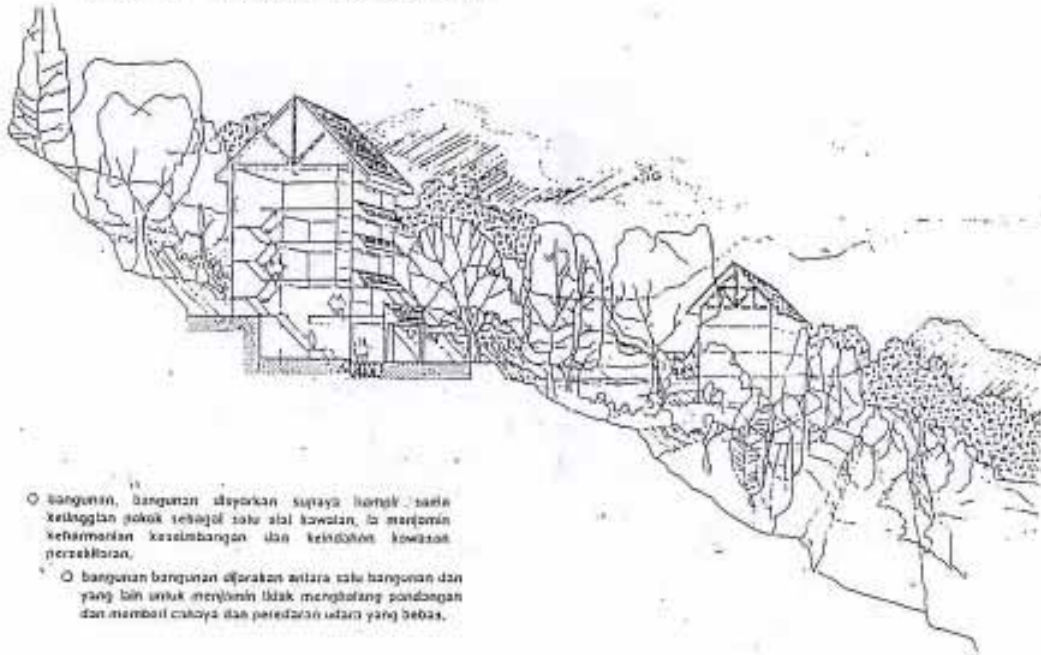
C. cadangan bangunan di lereng bukit atau pun di lereng rata diayarkan bangunan diantara 3 hingga 5 tingkat sahaja. Ketinggian bangunan disesuaikan dengan elemen persekitaran bagi mengujutkan suasana yang harmonial dengan alam persekitaran.



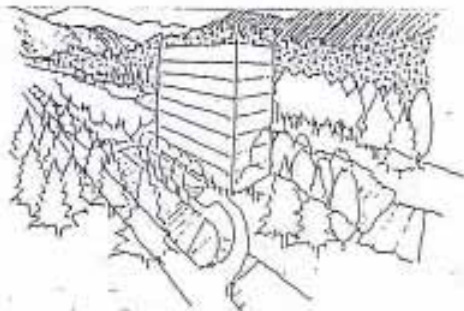
REKABENTUK BANGUNAN

ILLUSTRATION 6.4 : BUILDING ORIENTATION AND DESIGN

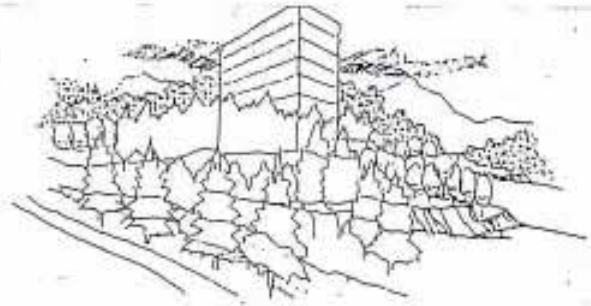
RAJAH 14 REKABENTUK BANGUNAN



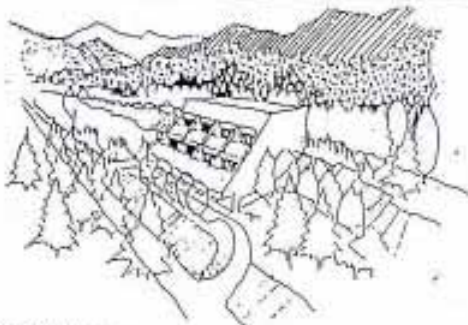
- bangunan, bangunan dipaparkan supaya bentuk serta kelengkapan pokok sebagai satu alat kawalan, ia menjamin keharmonian keseimbangan dan kestabilan kawasan persekitaran.
- bangunan bangunan dipaparkan antara satu bangunan dan yang lain untuk menjamin tidak menghalang pandangan dan mambail cahaya dan pendedahan udara yang bebas.



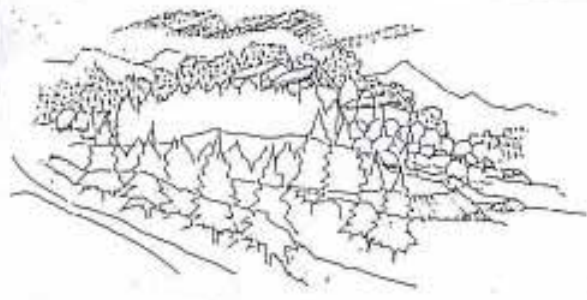
- rekabentuk bangunan yang tidak sesuai di kawasan landai kelengkapan bangunan yang tidak tinggi melebihi kelengkapan pokok memberi kesan pandangan 'eye sore'.



- contoh rekabentuk bangunan yang tidak sesuai di kawasan berbukit, bangunan memuncak keatas melebihi kelengkapan menyebabkan kesan yang tidak harmoni dengan keadaan sekeliling.



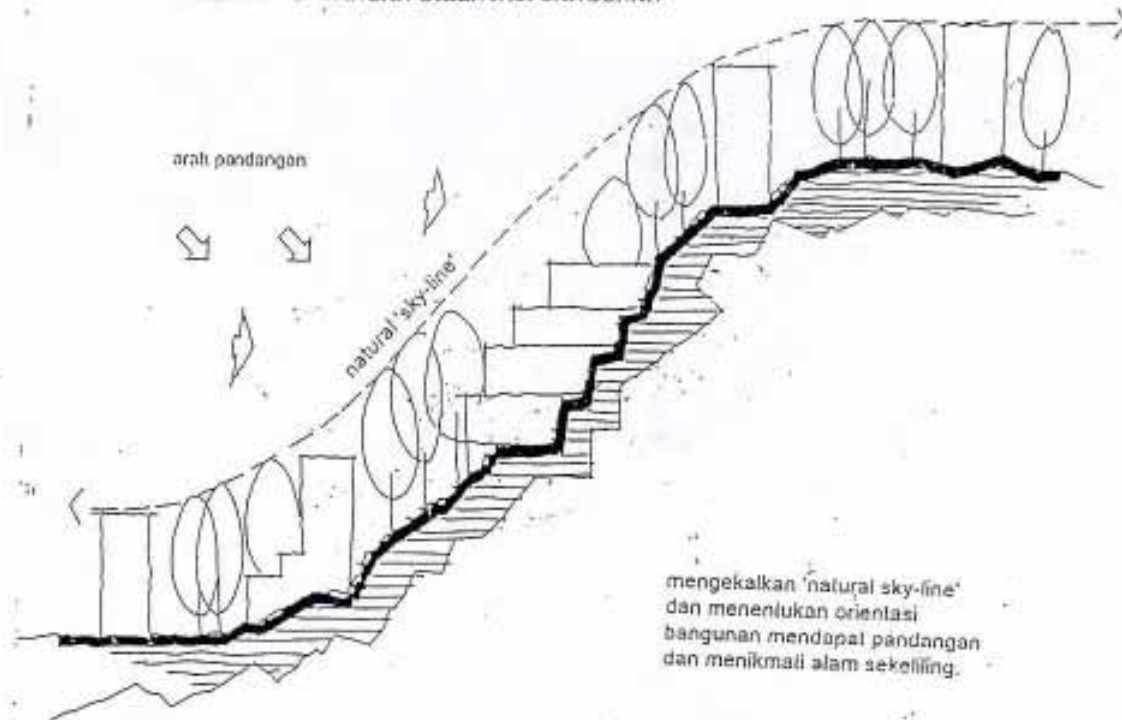
- rekabentuk bangunan yang sesuai di lereng bukit. Aras kelengkapan bangunan meningkat mengikut keadaan topografi dan kelengkapan bangunan adalah berkemungkinan disesuaikan dengan keadaan lereng bukit.



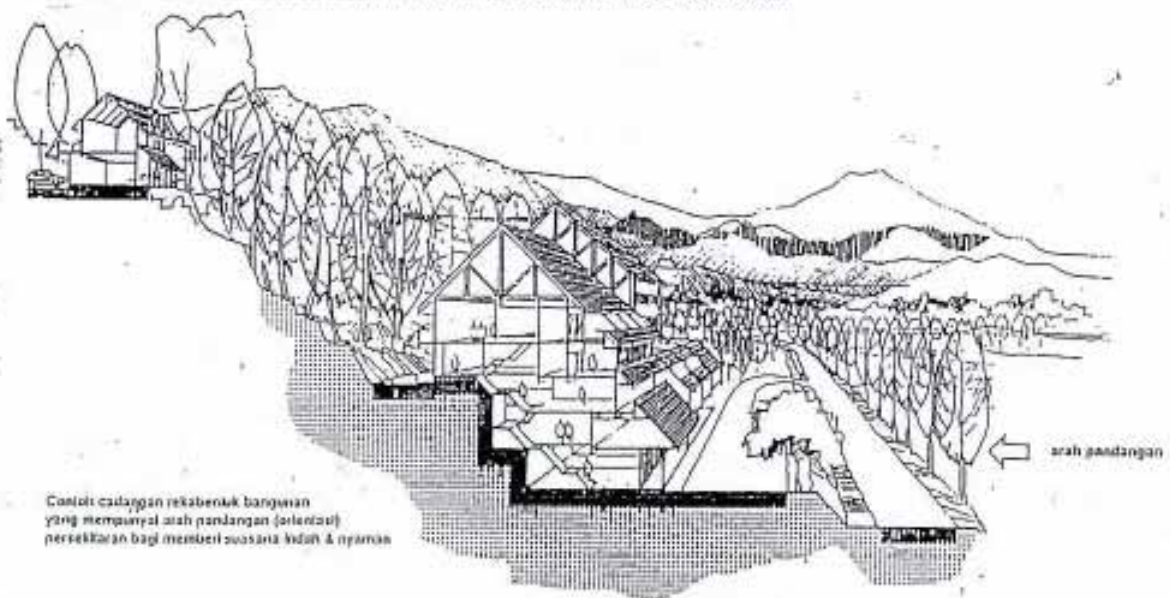
- contoh rekabentuk bangunan dipaparkan bentuk atau lereng bukit. Bangunan dipaparkan supaya disesuaikan dengan pokok-pokok bukit bagi menjamin 'natural sky line'.

ILLUSTRATION 6.5 : BUILDING ORIENTATION AND DESIGN

RAJAH 1e CADANGAN ORIENTASI BANGUNAN



RAJAH 1f CONTOH CADANGAN REKABENTUK ORIENTASI BANGUNAN



ORIENTASI BANGUNAN

- Setback requirements and buffer zones must be incorporated into the planning and design process to reduce adverse environmental impacts.
- Formulate Environmental Management System to continuously monitor and improve quality of air, water and solid waste management.

4. Open Space and Recreation

- Maximising the assets of the natural environment such as the water bodies, particularly ponds and/or lakes, hills and greenery, to create a garden city or Forest Park image wherever relevant.
- Preserve large areas and open spaces sufficient to meet the long-term needs of the lake catchment.
- Develop and maintain a balanced city-wide system of high quality public open space.
- Land for open space and recreational use should not be alienated to any private ownership.
- Open spaces and recreational areas, which can generate economic gains such as Theme Parks, Botanical and Herbal Gardens, should be encouraged.
- Multipurpose open space should be provided for each of the neighbourhood centres. This is mainly to hold public activities such as children's playground or community fairs.
- Other open spaces are reserved for greeneries at the appropriate locations. These may be used as green areas to act as visual barriers and for screening.
- Creating a continuous network of green belts and buffers that run throughout the whole development.
- Functional open spaces should be provided for leisure activities.
- Designs of appropriate open spaces, meeting places, eating areas or place settings such as plazas, promenades, boulevards, open theatre and the like to cater for day to day activities or for festive events, cultural processions or activities.
- Designs to encourage participative, healthy and socio-cultural activities.

- Provide easily accessible and affordable public park amenities, facilities and recreational opportunities for the general public, especially for the under privileged.
- Identify and provide appropriate mechanisms for adequate management and sensitive environmental and ecological areas such as water bodies, wetlands, highlands and steep terrain.

5. *Institutional*

- Incorporate comprehensive research and educational facilities such as libraries, research centres, information kiosks, educational guides and literatures.
- The institutions within the lake catchment will have a spin-off effect and would benefit supporting Putrajaya development and its environment.
- Preserving and promoting a park-like environment. Intensity in terms of overall gross plot ratios (GPR) with low intensity area with GPR of 0.5 or maximum nett plot ratio of 1:1.
- A minimum requirement of 10% to 15% of total area should be set aside for public open space.
- Plinth area or site coverage permitted to a maximum of 60% of individual site areas.

6. *Infrastructure and Utilities*

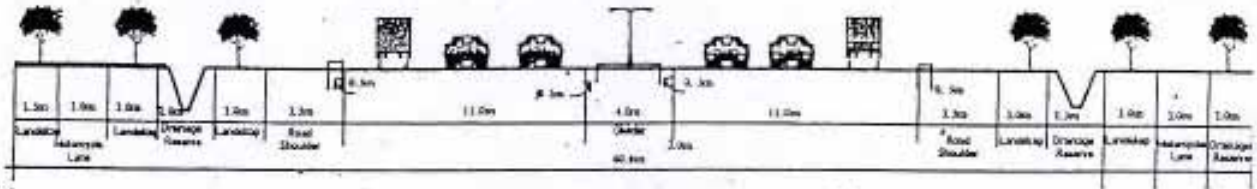
Roads

- Throughout the development region, the road networks should consist of the following hierarchy (Illustration 6.6);
 - i. Expressways
 - Providing inter-region and inter-state communication linkages.
 - U6 design standard with minimum reserve width of 60 metres.
 - Three-lane, dual-carriageways with provision for an additional lane in the future.
 - All junctions and intersections are grade-separated with full access control.

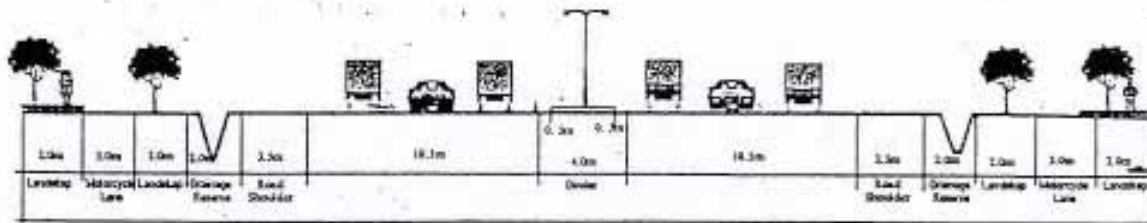
ILLUSTRATION 6.6 : TYPICAL ROAD CROSS SECTIONS

ustration 6.1: Typical Road Cross Sections

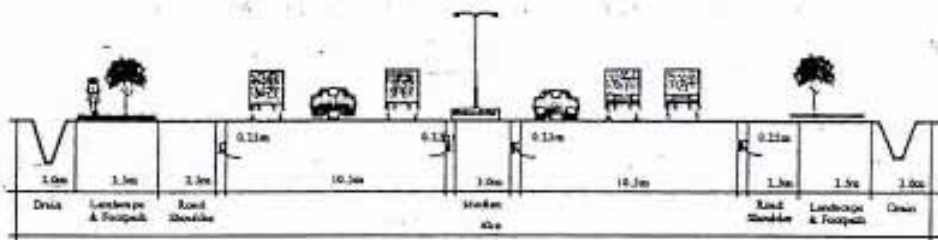
EXPRESSWAY (U 5)



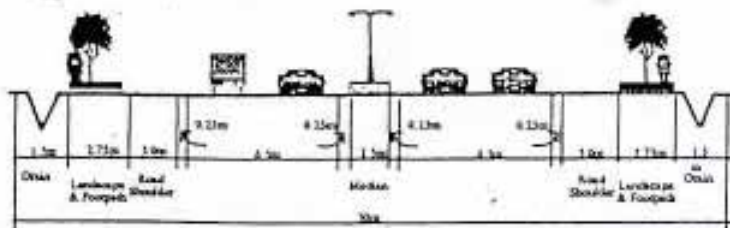
PRIMARY DISTRIBUTOR (U 5)



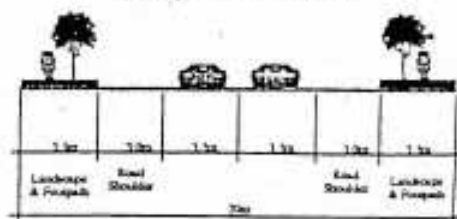
SECONDARY DISTRIBUTOR (U 4)



LOCAL DISTRIBUTOR (U 3)



LOCAL ACCESS (U 2)



- ii. Primary Distributors
 - Providing linkages between U6 Expressways and the internal areas.
 - U5 design standard with a minimum reserve of 50 meters.
 - Also three lane dual-carriageways with provision for an additional lane in the future.
 - All junctions are to be grade-separated but with partial access control.

- iii. Secondary Distributors
 - Providing access between development areas within a locality.
 - U4 design standard with a minimum reserve of 40 metres.
 - Three lane dual-carriageways.
 - Junctions are at-grade with partial access control.

- iv. Local Distributors
 - Connect adjacent landuses.
 - 2 lane dual-carriageways of U3 design standard with 30 metre minimum reserve width.
 - At grade junctions with partial access control.

- v. Local Accesses
 - Provide access to individual lots
 - U2 design standards with minimum reserves of 20 metres.
 - U1 design standards with minimum reserves of 12 metres.
 - 2 lane single-carriageways with no access control.

- The pedestrian walkways and bicycle paths should be provided within the landscaping reserves.
- Independent footpath networks for the purpose of facilitating social interaction should be provided in residential, institutional zones, linking them to

neighbourhood centres as well as to public transport station.

- The use of road reserves for utility trenching should be limited to the outer edge of the carriageways.

Drainage

- The storm drains should be connected to a system of trunk and secondary drains which ends at an existing river/waterbody.
- Treated waste water from the Sewage Treatment Plant may be released into rivers or streams only after meeting the Putrajaya Effluent Quality Standards. This level is to be strictly adhered to at all times to prevent water pollution.
- The treated water may also be used for landscaping purposes.
- All drainage design in the catchment are to conform to the Putrajaya Stormwater Management Design Guidelines.
- The drainage reserve requirements in the catchment shall follow those specified in the DID Urban Drainage Design Standards (UDDS).
- The individual land owners and project proponents are to be responsible for the construction of the drainage systems in their individual lots. The local authorities must monitor and ensure that the drainage systems are constructed according to the recommended guidelines.

Sewerage

- Sewerage design will accommodate modern sewage treatment system that will not only meet specific standard as stipulated by the Environmental Quality (Sewerage and Industrial effluents) Regulation 1979 for effluent discharge but also keep the limit for nutrient into the waterbodies to a minimum.

7. Construction

- The working area for various facilities within a construction site should be kept to less than twice the plinths of the building.
- Development schedule must be clearly defined. Completion date for each phase of development shall be indicated and all clearing, grading and stabilisation operations shall be completed before moving onto the next phase.
- Timing of construction activities shall, wherever possible, be spread evenly over the development time-scale to ensure that the deleterious effects arising from construction activities are minimised.
- All known rare and endemic flora and fauna areas or niches within the construction site shall be demarcated and preserved.
- All trees that are rare shall be fenced and preserved or carefully uprooted and transferred to a nursery/another site for replanting.
- Roads and permanent storm drains should be installed as early as possible so that they can control runoff during construction. However, they should be temporarily connected to the sediment basins until stabilisation of graded areas is achieved.

6.6.3.2 Specific Guidelines

(1) Universiti Putra Malaysia (UPM)

- All development must follow Planning Standard, Lake Catchment Guidelines, Putrajaya Guidelines and MSC Guidelines.
- Faculty, Hostels, Administration and others building planned within the lake catchment area should be clustered as an institutional village.
- The institutional area will comprise of academic uses and R&D centres and other supporting institutional elements e.g. laboratories, sports complex, shops, mosque, etc.
- Medical/laboratory development should discharge their waste outside the catchment.

- Maximum number of storeys permissible is 4 storeys for low intensity area and 5 storeys for the medium intensity area.
- Only low and medium intensity development with an overall gross plot ratios (GPR) are permitted as below;
 - Low intensity area with maximum GPR of 1:0.5
 - Medium intensity area with maximum GPR of 1:1
- Conserve and well-balanced reserve of 'green lung' as sources of pollution filters and buffers for the sustenance of the overall development and environment.
- A minimum of 30% of the individual development parcel should be landscaped and be set aside as green area.
- A minimum of 30m riparian buffer should be landscaped along the development parcel, e.g. roads, water bodies, ERL's and highways.
- Maximising the assets of the natural environment such as water bodies, particularly ponds/lakes, hills and greenery and to create a garden city or recreational park image.
- Preserve large areas and open spaces sufficient to meet the long range needs of the lake catchment.
- Other open spaces are reserved for greeneries at appropriate location. These may be used as green areas to act as visual barrier and for screening.
- Creating a continuous network of green belt and buffer that runs throughout the whole development.
- Functional open spaces should be provided to utilise for leisure activities.
- Design of appropriate open spaces, meeting places, eating areas or place settings such as plazas, promenades, boulevards, open theatre and the like to cater for day to day activities or for festive events, cultural processions or activities.
- Provide easily accessible and affordable public parks amenities, facilities and recreational opportunities for the general public with interaction of students, especially for the under privileged.

(2) MARDI

- All development must follow Planning Standard, Lake Catchment Guidelines, Putrajaya Guidelines and MSC Guidelines.

- Institutional building planned within the lake catchment area should be clustered as an institutional village.
- The institutional area will comprise of R&D centres, laboratories, etc.
- Maximum number of storeys permissible is 4 storeys for low intensity area and 5 storeys for the medium intensity area.
- Only low and medium intensity development with an overall gross plot ratios (GPR) are permitted as below;
 - Low intensity area with maximum GPR of 1:0.5
 - Medium intensity are with maximum GPR of 1:1
- Building setback is to be provided between buildings and roads to provide a green buffer and landscaping within each parcel. The front setback for each individual parcel should be at least 9m while a minimum of 6m setback for all sides.
- A minimum of 30% of the individual development parcel should be landscaped and be set aside as green area.
- A minimum of 30m green buffer should be landscaped along the development parcel, e.g. roads, water bodies, ERL's and highways.
- Conserve and balance well the reserve of 'green lung' as sources of pollution filters and buffers for the sustenance of the overall development and environment.
- Maximising the assets of the natural environment such as water bodies, particularly ponds/lakes, hills and greenery and to create a garden city or forest park image.
- Preserve large areas and open spaces sufficient to meet the long range needs of the lake catchment.
- Open spaces and recreational areas such as Theme Parks, Botanical Garden and Herbal Garden, which can generate economic gains should be encouraged.
- Other open spaces are reserved for greeneries at appropriate location. These may be used as green areas to act as visual barrier and for screening.
- Creating a continuous network of green belt and buffer that runs throughout the whole development.
- Functional open spaces should be provided to utilise for leisure activities.
- Design of appropriate open spaces, meeting places, eating areas or place settings such as plazas, promenades, boulevards, open theatre and the like to cater for day to

day activities or for festive events, cultural processions or activities.

- Provide easily accessible and affordable public parks amenities, facilities and recreational opportunities for the general public, especially for the under privileged.
- Stream buffers shall be retained for rivers, the width of the buffers shall follow the DID regulations.

(3) *TNB Serdang Power Plant*

- No further development is allowed in this area except, development to reduce the risk due to emergencies related to the operation of the existing TNB Power Station.

(4) *IOI*

- All development must follow Planning Standard, Lake Catchment Guidelines, Putrajaya Guidelines and MSC Guidelines.
- Housing layouts shall be cluster type to reduce the total length of roads and the extent of corresponding infrastructure.
- The residential development shall be in harmony with the site conditions and adapted to the surrounding terrain.
- The intensity of housing shall be based on 15 units per hectare.
- Maximising the assets of the natural environment such as water bodies, particularly ponds/lakes, hills and greenery and to create a resort and homestead image.
- Orientation and design of buildings which optimise views, water bodies and parks, respect and consider privacy and design art of adjacent buildings.
- Create a balanced and attractive building skyline which is in harmony with their surrounding natural physical features such as hills, water bodies and parks.
- For hilly land, terracing shall be done and maintained. Cover plants shall be established on the slopes of the platforms and walls of terrace immediately after commencement of earthworks.

(5) *West Country*

- All development must follow Planning Standard, Lake Catchment Guidelines, Putrajaya Guidelines and MSC Guidelines.
- Housing layouts shall be cluster type to reduce the total length of roads and the extent of corresponding infrastructure.
- The residential development shall be in harmony with the site conditions and adapted to the surrounding terrain.
- The intensity of housing shall be based on 15 units per hectare.
- Maximising the assets of the natural environment such as water bodies, particularly ponds/lakes, hills and greenery and to create a resort and homestead image.
- Orientation and design of buildings which optimise views, water bodies and parks, respect and consider privacy and design art of adjacent buildings.
- Create a balanced and attractive building skyline which is in harmony with their surrounding natural physical features such as hills, water bodies and parks.
- Terrace type housing layout should be avoided.
- A minimum of 30m green buffer should be landscaped along the development parcel, e.g. roads, water bodies and highways.
- For hilly land, terracing shall be done and maintained. Cover plants shall be established on the slopes of the platforms and walls of terrace immediately after commencement of earthworks.

(6) *Universiti Tenaga Nasional (UNITEN)*

- All development must follow Planning Standard, Lake Catchment Guidelines, Putrajaya Guidelines and MSC Guidelines.
- Faculty, Hostels, Administration and other supporting institutional buildings planned within the lake catchment area should be clustered as an institutional village.
- The institutional area will comprise of academic uses and R&D centres and other supporting institutional element, e.g. laboratories, sports complex, shops, mosque etc.

- Maximum number of storeys permissible is 4 storeys for low intensity area and 5 storeys for the medium intensity area.
- Only low and medium intensity development with an overall gross plot ratios (GPR) are permitted as below;
 - Low intensity area with maximum GPR of 1:0.5
 - Medium intensity area with maximum GPR of 1:1
- Conserve and balance well the reserve of 'green lung' as sources of pollution filters and buffers for the sustenance of the overall development and environment.
- Maximising the assets of the natural environment such as water bodies, particularly ponds/lakes, hills and greenery and to create a garden city or forest park image.
- Preserve large areas and open spaces sufficient to meet the long range needs of the lake catchment.
- Other open spaces are reserved for greeneries at appropriate location. These may be used as green areas to act as visual barrier and for screening.
- Creating a continuous network of green belt and buffer that runs throughout the whole development.
- Functional open spaces should be provided to utilise for leisure activities.
- Design of appropriate open spaces, meeting places, eating areas or place settings such as plazas, promenades, boulevards, open theatre and the like to cater for day to day activities or for festive events, cultural processions or activities.
- Provide easily accessible and affordable public parks amenities, facilities and recreational opportunities for the general public, especially for the under privileged.

(7) *Sg. Merab Malay Reserve*

- All development must follow Planning Standard, Lake Catchment Guidelines, Putrajaya Guidelines and MSC Guidelines.
- Housing layouts shall be cluster type to reduce the total length of roads and the extend of corresponding infrastructure.
- The residential development shall be in harmony with the site conditions and adapted to the surrounding terrain.

- The intensity of housing shall be based on 15 units per hectare (6 upe).
- Maximising the assets of the natural environment such as water bodies, particularly ponds/lakes, hills and greenery and to create a resort and homestead image.
- Orientation and design of buildings which optimise views, water bodies and parks, respect and consider privacy and design art of adjacent buildings.
- Create balanced and attractive building skyline which is in harmony with their surrounding natural physical features such as hills, water bodies and parks.
- For hilly land, terracing shall be done and maintained. Cover plants shall be established on the slopes of the platforms and walls of terrace immediately after commencement of earthworks.

(8) *Utilities Areas*

- All development must follows Planning Standard, Lake Catchment Guidelines, Putrajaya Guidelines and MSC Guidelines.
- A minimum of 30m green buffer should be landscaped along the development parcel, e.g. roads, water bodies, ERL's and highways.
- Road shoulders are to be protected mechanically or vegetatively against erosion.
- Roads, permanent storm drains and other utilities should be installed as early as possible so that they can control runoff during construction. However, they should be temporarily connected to the sediment basins until stabilisation of graded areas is achieved.
- Runoff water should be directed so that it does not run across disturbed and unstable areas.
- The storm drains should be connected to the existing water bodies such as ex-mining pools for flood prevention purposes.

CHAPTER 7

DEVELOPMENT OF THE BASIC ICMS

7.0 DEVELOPMENT OF THE BASIC ICMS

7.1 INTRODUCTION

7.1.1 For the successful implementation of the Catchment Development and Management Plan there is a need to develop an information management system that will provide adequate and timely processed information related to the Plan for use by pertinent decision-makers. Thus, the Consultant has proposed that a *basic or low-level* Integrated Catchment Management System (ICMS) be developed as part of this study to support decision-making on the implementation of the Plan.

7.1.2 The complete ICMS is envisaged by the Consultant to be an IT-based decision support system comprising of four components, as illustrated in Figure 7.1. They are:

- Data and information pre-processing
- Information system
- Analytical system
- Graphical user interface (GUI)

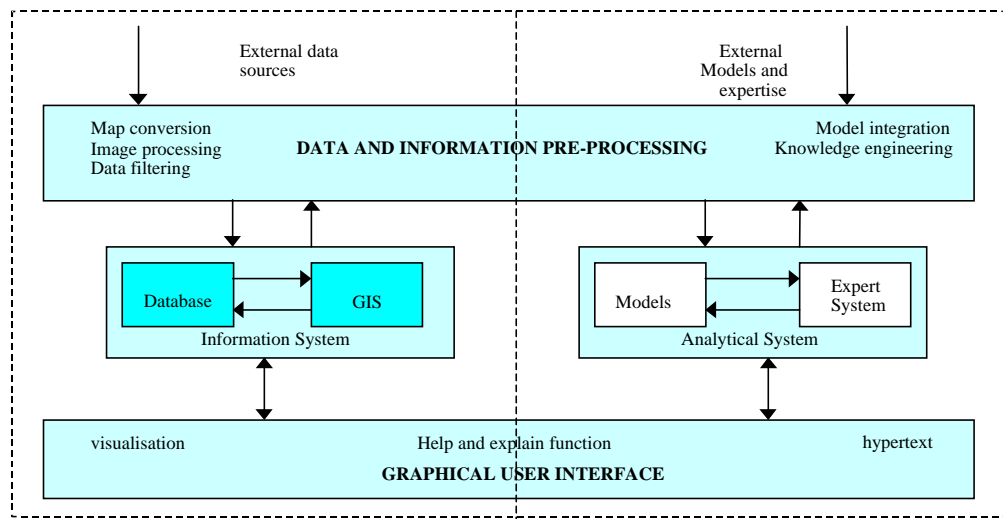


Figure 7.1 The Complete ICMS

7.1.3 At this stage of the study it is only feasible to develop the information system component, comprising of the information database and the Geographical Information System (GIS) used to manage the information in the database. Thus, the low-level ICMS will involve work to develop the Information System

component and its associated data inputs pre-processing and outputs visualisation.

7.1.4 To support the development and maintenance of the ICMS, there is a need to define an Information Management Plan (IMP). The IMP will address all the major issues of information flow within an organisation. It will also highlight the importance of having a management structure for data sharing and the need to classify information.

7.1.5 The system development life cycle for the low-level ICMS is illustrated in Figure 7.2. The steps are as follows:

- (a) User requirements study
- (b) System design
- (c) System development
- (d) System implementation
- (e) Maintenance and support

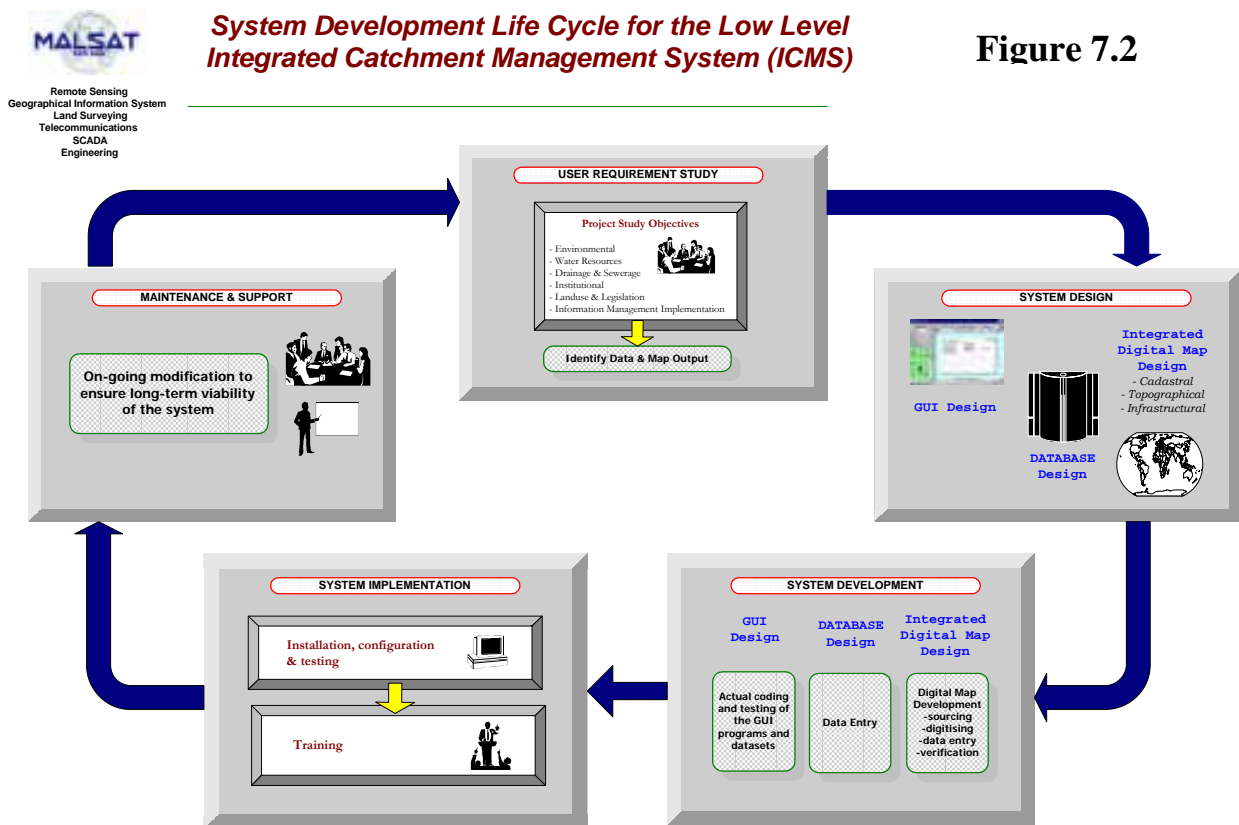


Figure 7.2

NOTE : - With each cycle, the ICMS functionality should be enhanced and become more sophisticated
 - This development life cycle allows for the ICMS to be developed in stages depending on priorities and budget

7.2 INFORMATION MANAGEMENT PLAN (IMP)

7.2.1 The need for an IMP

7.2.1.1 The basic requirement for integrated catchment management is comprehensive understanding of the catchment, its physical forms and functions. This can only be achieved if data and information on the catchment are sufficient and accurate.

7.2.1.2 Within the Perbadanan Putrajaya, the various technical units must be diligent in the management of the data collected as part of the environmental monitoring programmes. Proper management of data is important to enable it to pass on processed information for decision-making.

7.2.1.3 Whilst data and information are available for areas within the Putrajaya administrative boundary, gaps in information may exist for areas outside it. With data residing and owned by different parties, there is a clear need to have an understanding between the Perbadanan Putrajaya and the other stakeholders in the catchment on the issue of sharing of certain information for mutual development benefits.

7.2.1.4 Thus, an Information Management Plan is necessary to facilitate the handling and management of information related to the management of the Putrajaya catchment. It is an essential component of the study to develop and implement the Integrated Catchment Management System.

7.2.2 Information Sharing

7.2.2.1 Objectives of Information Sharing

- (1) Information sharing is important for successful integrated catchment management. It's main purpose is to provide information to all parties with interests in the catchment based on the principle that proper management can only be achieved with continuous growth of knowledge and understanding of the catchment and its issues.
- (2) It encompasses all levels of society - from government and local authorities to property developers and landowners, and even to the general public.

- (3) For the Putrajaya Lake catchment, information sharing can achieve the following objectives:-
- Avoid duplication of effort in data collection in the catchment
 - Co-ordinate approach in obtaining data types that transcend property boundaries
 - Prepare plans for individual development based on information from the same source
 - Pool information for participatory management of the catchment
 - Pave the way for future close co-operation on development and environmental issues
- (4) One way to avoid duplication of effort in data collection is by creating a co-ordinated local data resource base. The benefit of this data resource base has been long realised but the implementation of data sharing mechanisms, although attempted at various levels and sectors of Government, are often hampered by bureaucracy and lack of continuity in representation. The ongoing National Land Information System (NALIS), however, proves that concerted effort and planning in data sharing can be successful.
- (5) With the formation of the Putrajaya Lake Catchment Management Committee, a platform to discuss major developmental concerns has been created. A Technical Committee has also been formed to address technical issues. Information sharing is one of the agendas of this technical committee and this Plan shall further refine the needs of information sharing.

7.2.2.2 *Benefits of Information Sharing*

- (1) In promoting data sharing amongst multiple stakeholders, one of the most common questions asked by stakeholders is what are the benefits for them? The benefits of information sharing amongst stakeholders can be summarised as follows:
- Access to up-to-date information on the catchment area.

- Conflicting issues on development will manifest earlier allowing time for discussion and solution before permanent changes take place
 - Avoids duplication of data collection efforts
 - Identification of gaps in information
 - Greater awareness of the area as a whole
 - Learning from the experience of other stakeholders
 - General public appreciation of environment
- (2) Information sharing usually paves the way for future two-way co-operation in handling joint concerns. It is critical however; that a consensus is reached by all involved as to the mechanism for data sharing.

7.2.3 Obtaining Information

7.2.3.1 Information sharing between stakeholders requires several issues to be discussed and agreed upon by all. They are described below:

7.2.3.2 Inventory of Information - *Determine what information is held elsewhere and how it can be obtained*

7.2.3.3 Copyrights and Sharing Conditions - *Ownership and copyrights must be respected hence the limitations to the use of information passed on by one stakeholder to another must be stated and agreed upon. For example, the information should not be made available to a third party without the express consent of the original source.*

7.2.3.4 Information requirements - *The information or data to be shared should be clearly defined. The type of information, the format in which it is required and the time period expected for the request to be met. The setting of a deadline for response indicates the seriousness of the request and implies that there will be impending downstream action.*

7.2.3.5 Regular Contact - *Stakeholders must often be in touch with each other in order for information status to be continuously updated. The catchment committee meetings may be spaced too far apart to allow for successful implementation of the information management strategy. Hence a smaller but more technical group may be appropriate. This technical group*

could meet bi-monthly to report on data updates and address other information-related issues.

7.2.4 Assessment of Response to Information Request

7.2.4.1 In the effort to understand stakeholders' concerns, several meetings were held with the stakeholders during the study. Corresponding to this, information management survey questionnaires were distributed. The purpose of the survey is to inquire on the presence of information among the stakeholders and identify general concerns.

7.2.4.2 Only two out of ten stakeholders (including local authority) responded. Most stakeholders however did respond by agreeing to meetings where mutual issues on data were discussed. In most cases, the developers were represented by their engineering consultants. The sectoral experts were quite successful in obtaining information from the stakeholders only after explaining at length the reasons and objectives of the study.

7.2.5 Information Dissemination

7.2.5.1 To encourage stakeholders and the general public's participation in catchment management, correct and accurate information should be periodically made available to the stakeholders and the general public. This can be in various forms and in several levels of detail. For example:

- Reports – technical or management reports on engineering, environment or development status targeted for internal use or academic interest
- Booklets – guidelines to development in the catchment targeted at developers, engineers and environment managers
- Pamphlets/Brochure – summary of information; Putrajaya map of roads and buildings targeted for general public
- Newsletters – summary of study findings, current affairs, warnings of potential hazards, public announcements
- Internet – website on areas of interest in the Putrajaya catchment such as buildings, wetlands and current issues.

7.2.5.2 The release of information by government agencies to the private sector and the general public is usually hampered by the

lack of an official information policy. Thus, there is a need to define an appropriate Information Management Policy.

7.2.5.3 For sharing to be successful, data should be appropriately classified and clearance of data for public use can be co-ordinated by a committee entrusted with the task.

7.2.6 Perbadanan Putrajaya as Lead Agency for Information Management

7.2.6.1 The stakeholder that will benefit most from information sharing is Perbadanan Putrajaya. Thus, it should be the leading stakeholder in this catchment to provide information sharing and must play a proactive role.

7.2.6.2 Perbadanan Putrajaya has the necessary resources to carry out the necessary environmental monitoring operations in the areas of the other stakeholders to support the lake Management. This could include:

- Establishing water quality measuring stations within the areas owned by stakeholders
- Providing data to stakeholders e.g. rainfall, streamflow, water quality
- Providing overall landuse maps of the catchment area
- Advice on environment and development issues
- Central depository for data collected by stakeholders
- Providing digital information
- Commission research activities which encompass the entire catchment

7.2.6.3 However, for any of the services provided above, a reciprocal contribution should be provided by the other stakeholders.

7.2.6.4 A co-ordinated local data resource base should be designed to avoid duplication of effort in data collection. This benefit has been long realised by the Government but the implementation of data sharing mechanisms, although attempted at various levels and sectors, are often hampered by bureaucracy and lack of continuity in representation.

- 7.2.6.5 Due to its technical and administrative capabilities, Perbadanan Putrajaya is well positioned to take the lead as the data resource base for the Putrajaya catchment.
- 7.2.6.6 Data held centrally by an agreed organisation facilitates a common mechanism for data sharing. Hence, plans for individual development can be based on information from the same source.
- 7.2.6.7 Thus, it is recommended that Perbadanan Putrajaya should play the role of data custodian for the catchment and the referral centre for development-related information. Appendix 7.1 gives the details on how the Perbadanan can carry out this function.

7.3 ICMS - USER REQUIREMENTS STUDY

- 7.3.1 The first step in the development of the low-level ICMS is to identify the information management needs of the end-user of the ICMS. The information to be identified are the monitoring datasets to be collected and processed, and all informative maps that are necessary to support decision-making in the catchment.
- 7.3.2 Based on the identified information the IT team will design the structure of the database, process into digital form all pertinent maps, and design the necessary linkages between the data and maps, so as to integrate the spatial and attribute data information in the database.
- 7.3.3 The “enduser” for the *Basic ICMS* will be Perbadanan Putrajaya. However, since the various studies are out-sourced by Perbadanan Putrajaya to Consultants, the User Request Study (URS) was carried out by focussing more on the scope of work of the Consultants, and the expected data and map outputs which will be delivered to the “enduser”. Additionally, the URS also took into account the Perbadanan Putrajaya’s existing and planned IT infrastructure, objectives and manpower resources.

7.4 SYSTEM DESIGN

7.4.1 Introduction

7.4.1.1 In developing the system design for the low-level ICMS the IT team is guided by the following consideration:

- (a) The design should be compatible with Perbadanan Putrajaya's IT system – the *Sumber Putra*.
- (b) The design should allow information stored in it to be easily exported to other IT systems.
- (c) The design should take into account the level of IT literacy of the potential end-user.

7.4.1.2 Based on the above consideration the IT team has defined the system requirements for the software and hardware for the low-level ICMS. Detail discussion on the Sumber Putra IT system and on the IT team's assessment are described below.

7.4.2 The Perbadanan's IT System

7.4.2.1 The current desktop workstations in the Perbadanan Putrajaya run on Windows NT with a Unix server at the heart of the network. The Unix is opaque to the general users. The desktop software used by the Perbadanan's staff includes the Microsoft Office 98 suite of programmes. All softwares are server-installed and hence a protocol for software usage already exists.

7.4.2.2 AutoCAD release 14 by Autodesk is currently the Perbadanan Putrajaya standard for the development of plans and design drawings. Autocad Map also by Autodesk, is also used by some technical Units to provide the GIS facility.

7.4.3 The Sumber Putra IT System

7.4.3.1 The Sumber Putra IT system represents the core of Perbadanan Putrajaya's IT development. The system is still in the early stages of development and is reported to comprise of five different applications.

7.4.3.2 Work on the first and flagship – the Electronic Submission Standards (ESS) system, is in progress. The following are details on the ESS system provided by the Perbadanan's IT consultant, Mr. Rishipal Singh from Novasprint.

7.4.3.3 *Electronic Submission Standards (ESS) System - Introduction*

- (1) The ESS system is an electronic system for the processing and approval of electronic submissions by project proponents, on all aspects of planning approval to the Perbadanan. It consists of two parts. They are:
 - A main processing system at the Perbadanan Putrajaya and,
 - A user-end module use by the project proponents to submit his drawing/plans electronically to the Perbadanan.
- (2) To submit its plans electronically the project proponent must adhere to a standard digital drawing format, which define details for the thickness of each line entity and the standard icons for point entities.
- (3) The ESS is designed to be an intelligent system, i.e. it is supposed to conduct the routine checks on the electronic drawings submitted to ensure compliance to the Perbadanan's standard drawing format. It also includes provision for registration, confidentiality, security and re-submission, in case of non-compliance.

7.4.3.4 *ESS System – User-end Module*

- (1) A project proponent has to purchase the user-end module of the ESS from the Perbadanan. The module contains a software and a guideline that describes the outlines of the hardware requirements to establish an online link with the Perbadanan Putrajaya's ESS.
- (2) The hardware required to connect with the ESS is no different from those used normally by a user to connect with the Internet.
- (3) The drawing format for submission to the ESS is the AutoCAD - dxf file format, which is the de-facto standard due to its wide application in the local engineering scene. The accompanying database has to be prepared using Microsoft Access.
- (4) The user-end ESS module is designed to take advantage of the availability of off-the-shelf software and comprises of a user-friendly graphical user interface that facilitates the entry of submission and drawing information.

- (5) Once the entry form is filled, the information can be submitted via a modem through the Internet connection to the Perbadanan Putrajaya.

7.4.3.5 *ESS System – System-end Module*

- (1) At the Perbadanan Putrajaya the ESS is run on a network platform with a UNIX server at its core.
- (2) The operating system for the workstations used by the Perbadanan's staff runs on Windows NT.
- (3) The system database is Oracle which remains opaque to the workstation users.

7.4.3.6 *ESS System – Vetting of submission*

- (1) There are two levels of vetting of the submitted documents. The first stage is a non-interactive stage and the second stage requires interaction with the staff in the Perbadanan's technical Units.
- (2) In the first stage the ESS system screens and analyses the electronic submissions for general compliance to the Perbadanan's procedures and standards. Upon fulfilling the registration requirements the submitted documents undergo an electronic check for drawing format compliance. Only when this stage is cleared will the submission be channelled to the next stage for the interactive vetting by the relevant technical Units in the Perbadanan.
- (3) The Perbadanan's technical Units are responsible for assessing the feasibility and technical compliance of the development proposal plans. This vetting exercise is an interactive process with the ESS, where the assigned personnel query the ESS on the various technical aspects of the development plans. They would include an assessment of the proposal's compliance to building by-laws, buffer zone requirements, engineering and technical guidelines requirements.

7.4.4 The Software Requirements

7.4.4.1 *The Need*

- (1) There is a need to define the database and GIS software to be used for the development of the low-level ICMS. After taking

into consideration a number of factors the IT team has decided on the following database and GIS software. They are:

- Database - *Microsoft Access*
- GIS - *ArcView Rel. 3.0*

(2) The reasons for the above choices are described below.

7.4.4.2 Selection of Database Software

The Microsoft Access database program has been chosen for the development of the database in the low-level ICMS for the following reasons:

- (a) It is widely available, as it comes bundled with every purchase of the popular Microsoft Office Professional suite.
- (b) Microsoft Access is the database program used in the Sumber Putra IT system.
- (c) The Program is readily available on most workstations at the Perbadanan Putrajaya.
- (d) The database created using the Program is readily read by AutoCadMap, the GIS software currently used by a few technical units in the Perbadanan.
- (e) The learning curve for Microsoft Access is not very steep.

7.4.4.3 Selection of GIS software

(1) For the development of the ICMS, there was no necessity for immediate physical integration between the IT team's output and the ongoing Sumber Putra IT system. The developments for both systems can be independent of each other, with the ICMS eventually being subservient to the Sumber Putra. Since the ICMS is a low-level system, containing only digital databases and maps, future convergence with the Sumber Putra IT system or with any other IT system should not be a problem.

(2) Thus, for the development of the low-level ICMS, the IT team recommends that ArcView Rel. 3.0 GIS be used. The program is a simple, Windows-based GIS software.

(3) To familiarise the potential users of the low-level ICMS on its use, before it is incorporated as a component of Phase-2 of the Sumber Putra project, it is recommended that a copy of Arc View and a desktop computer be purchased.

7.5 SYSTEM DEVELOPMENT

The work of developing the low-level ICMS can be divided into 2 distinct components. They are:

- Development of the Integrated Digital Map
- Development of the database structure

7.5.1 Development of the Integrated Digital Map

7.5.1.1 Three groups of maps and their associated data will be generated from this study. They are Cadastral, Topographical and Infrastructure or Development maps. The nature of the map data is described below.

- (a) *Cadastral* data deals with information on property parcels, land ownership, size, land valuation, existing land use and zoning categories. Most, if not all, of the cadastral maps and data have already been digitised by the town planner.
- (b) *Topographical* data deals with information on the physical layout of the land such as terrain, contours, hills, lakes, rivers, watercourses, roads, buildings, etc.
- (c) *Infrastructure* data deals with information on the physical development that have been built or are being planned for the future, such as telecommunication, sewerage, water, electricity, highways and roads, buildings, etc.

7.5.1.2 Most of the topographical and infrastructure data covering Putrajaya is already in digital format, as part of Perbadanan Putrajaya's *Sumber Putra Information System Project*. For areas outside of Putrajaya, topographical and infrastructure maps will have to be obtained from the Survey and Mapping Department and from the other stakeholders within the catchment area.

7.5.1.3 These datasets have been organised into logical GIS layers and integrated into a common MRSO co-ordinate system in a single GIS platform (ArcView). By integrating these *datasets* into a GIS-technology environment in a logical manner and with comprehensive associated databases, the ultimate aim is to ensure that they become useful *information*.

- 7.5.1.4 Extensive geographical maps and data have and are being collected by the vendors of Sumber Putra as part of the Land Information System module and this has yet to be completed. The creation of the Integrated Digital Map was done progressively with a view to updating certain layers and data from Sumber Putra, as and when they are ready.
- 7.5.1.5 A common co-ordinate system has to be adopted for integrating the 3 datasets layers into a single GIS. The co-ordinate system to be adopted will logically follow those used in the Sumber Putra IT system, i.e. Cassini, MRSO, Latitude/Longitude or WGS84.
- 7.5.1.6 Some problems were encountered during the creation of the Integrated Digital Maps: -
- lack of available data outside Putrajaya
 - lack of knowledge of what data is available at Putrajaya as part of Sumber Putra
 - lack of metadata about the Sumber Putra maps and data
 - massive data editing required to convert from CAD to GIS format
- 7.5.1.7 Appendix 7.2 shows the Data Description for the development of the ICMS

7.5.2 Development of the Database Structure

7.5.2.1 Introduction

- (1) The implementation of the monitoring program in the Plan will result in the generation of a number of databases. The format of the digital data and the structure of their database tables have to be defined. Careful design of the table structure is essential to facilitate the design of queries, analysis and subsequently for tie-in with the spatial data in the GIS.
- (2) In the design of the datatable structures the IT team has taken into account the procedures for the data sampling and their subsequent processing into useful information. However, it must be noted that the format and design of the datatables presented in this study should be considered as basic. They should be improved as the monitoring programmes are refined and tailored to meet the needs of the pertinent end-user.

(3) The following are detail descriptions on the design of the following databases:

- Monitoring station location
- Water quality monitoring
- Wetlands
- Hydrology
- Drainage
- Sewerage

Appendix 7.3 gives the Database Manual developed for the low-level ICMS.

7.5.2.2 *Monitoring Station Location Database*

(1) A general structure for the database containing information on any monitoring station location has been developed. The table contains the following information:

- Monitoring station ID number - a unique number that differentiates one monitoring station from another
- Description of a station's location
- Latitude in degrees MRSO - to enable geo-referencing
- Longitude in degrees MRSO - to enable geo-referencing
- Date of first sampling - a historical record of the station's date of commissioning
- Maintained by – specify the ownership of the station and its data

(2) Photographs may also be added into the datatable to provide a visual description of the area.

7.5.2.3 *Water Quality Monitoring Database*

(1) The water quality monitoring requirements for Putrajaya Lake have been described in the Putrajaya Lake Management Guide. Based on the monitoring requirements four datatables are considered adequate for the water quality monitoring database. The four datatables are:

- Monitoring station location datatable (see Section 8.4.2.1)
- Job identification datatable
- Measurement record datatable

- Threshold datatable
- (2) Detail descriptions of the pertinent datatables are described below.

(a) Job identification datatable *WQJob*

The attributes of the data fields in this table are as follows:

- Water quality station ID number – This provides the link to the station location datatable
- Sampling Job Number – This is a unique identifier for each sampling job
- Sampling date
- Weather condition during sampling
- Initials of person doing the sampling
- Notes on any related field activity

The last three fields provide an audit trail for data quality assurance. The notes on any related field activity is a field provided for recording any in-situ observations that may influence the use or interpretation of the data.

(b) Measurement record datatable *WQSample*

The attributes of the data fields in this table are as follows:

- Sampling Job Number - This provides the link to the job identification datatable
- Sample number
- Time of sampling
- Depth of sampling in metres
- One or more fields for each of the measured parameters

Based on discussions with the environmental specialist the following five parameters have been recommended to be measured:

- pH value
- Dissolve Oxygen (DO)
- Suspended Solids (SS)
- Total Phosphorous (RP)

- Reactive Phosphorous (RP)

(c) Threshold datatable

A datatable containing the threshold values for all the water quality parameters listed in the Putrajaya Lake Water Quality Standard (see Appendix 5.3) has also been prepared to complement the other datatables of the water quality database. The threshold data will be useful for comparisons with the measured water quality data to check that they are within permissible levels.

7.5.2.4 Wetlands Database

(1) The wetlands database is an inventory of wetlands identified inside the Putrajaya catchment area including those outside the administrative boundaries of Putrajaya. Information on location, size, flora and fauna are included in the database.

(2) Detail descriptions of the pertinent datatables are described below.

(a) Wetlands datatable *Wetland1*

This datatable holds the location attributes of the wetland and is tied with the digital map. The wetlands of Putrajaya have been identified by the wetlands expert in his report. In this datatable, each wetland is given a unique identifier and key information including a name, size and georeference coordinates.

(b) Wetland subcells datatable *Wetland2*

This datatable holds subcells of *Wetland1*. It was designed primarily to identify the wetlands plant types in the subcell areas.

(c) Plant and wildlife datatables *XX_TerPlant, XXX_WetPlant, Fish1, Mammal1 and Bird1*

These are simple datatables for plant and wildlife inventory. They can be designed in a few ways but are usually more helpful when a picture is included.

7.5.2.5 *Hydrology Database*

- (1) This database is designed for hydrological information. Hydrological information includes rainfall, streamflow and sediment records. Each hydrological data collection station is identified by coordinates.
- (2) Detail descriptions of the pertinent datatables are described below.

(a) **Hydrological Station datatable *HydStation***

This is a datatable that identifies the location of hydrological stations i.e. for rainfall, evaporation or streamflow gauging stations. Geographical coordinates in the datatable connect the database with the relevant GIS map. Actual parameter records for any particular station can exist in a different datatable but linked to this.

7.5.2.6 *Drainage Plan Database*

- (1) The drainage database provides the user with information on location and size of drains corresponding to a line feature on the GIS map. This is a drainage structure information database which linked with the proposed drainage master plan drawing. The database will be associated with the line entities representing drainage structures.
- (2) Detail descriptions of the pertinent datatables are described below.

(a) **Drain datatable *DrainI***

This datatable will complement the final drainage map by displaying information on the drain type, size and maximum discharge including length and slope at the click of a button.

(b) **Gross Pollutant Trap datatable *GPT_DControl***

This datatable stores information on the gross pollutant traps designed as part of the drainage plan including design parameters and dimensions. GPTs are man-made structures constructed as part of the drainage system. As the name implies, its function is to trap all visible pollutants including rubbish, sediment and debris. GPTs have to be cleaned and maintained. GPT's are often built based on trial-and-error and may need to be redesigned to

meet efficiency requirements designs. The last record in this data table represents the current design.

(c) Gross Pollutant Trap Water Quality datatable *GPT_WQ1*

This water quality data table is associated with the GPT station. It keeps the records of suspended solids measurements entering and exiting the GPT. The efficiency of the structure based on the measurements recorded here can be calculated manually using the parameters or alternatively, a query can also be designed to calculate it automatically.

(d) Detention Pond datatable *DetPond1*

Eight areas within the Putrajaya area have been designated as permanent flood detention ponds. Outside the Putrajaya area, five areas have been found to be potential sites for flood detention ponds. DetPond1 is a datatable of detention ponds found in the Putrajaya catchment. Information provided therein includes the sub-catchments in which they are located as well as the size and width of the ponds.

7.5.2.7 Sewerage Database

(1) One potential point source pollutant to the Putrajaya Lake is the discharge of untreated or inadequately treated sewage effluent into the catchment drainage system of the lake. Among the information pertinent to manage sewage in Putrajaya is the location and capacity of the existing and proposed sewage treatment plants. This database houses this information and provides an overall view of the major sewage treatment facilities in the area.

(2) Detail descriptions of the pertinent datatables are described below.

(a) Sewage Treatment Plant datatable *STPlant1*

This datatable georeferences the location of all sewage treatment plants in the Putrajaya catchment both inside and outside the Putrajaya administrative boundaries. Records of the capacity of the sewage treatment plant, status of construction and information on the discharge from the plant can be included within STPlant1.

7.6 SYSTEM IMPLEMENTATION

7.6.1 Installation and ICMS Training for Users

The proposed basic stand-alone hardware system will first have to be purchased before training in the low-level ICMS can be conducted. This basic system comprises of one (1) licence ArcView release 3.0 and a desktop PC. Should Perbadanan Putrajaya defer the purchase of the software, the consultant will proceed to transfer the GIS files of the study over to the IT Unit in ESRI .dxf format.

7.6.2 Database Training

A hands-on session on water quality data entry is proposed using the forms and datatables designed by the MIS specialist. The Water Quality Specialist will be called in to conduct a water quality sampling assignment specifically to demonstrate the use of the data entry form and datatable. The session will include post-processing of water quality sample data using the existing datatables and basic analysis. The purpose of the training is to impart to Perbadanan Putrajaya personnel the basic database management skills using tools afforded by Microsoft Access and Excel. The target group will be the technical staff from the Environment, Lake and Hydrology Units of the City Planning Department.

7.7 SYSTEM MAINTENANCE AND SUPPORT

7.7.1 The low-level ICMS is a simple stand-alone system and the IT team do not envisage any difficulty for the Perbadanan's IT staff to carry out the routine maintenance and support tasks for the system.

7.7.2 Based on the IT team's understanding of the management requirements recommended by the various specialists, the IT team envisage the complete ICMS to comprise of the following core technologies :

- Real time monitoring system
- Geographical Information System
- Relational Database Management System
- Satellite Image Processing System
- Aerial Photography

- Web based decision support system

7.7.3 Brief descriptions on the technologies are given in the conceptual proposal for the complete ICMS in Appendix 7.4.

7.8 CONCLUSIONS AND RECOMMENDATIONS

7.8.1 Perbadanan Putrajaya is well positioned to play a leading role in the management of resources and information within the Putrajaya Lake catchment. To do this successfully, it needs up-to-date and accurate information.

7.8.2 The following are the IT Team's recommendations, in order of priority:

- (a) Perbadanan to purchase, as soon as possible, a copy of the ArcView GIS software and a stand-alone computer for the installation of the low-level ICMS, developed as part of this Study. The indicative cost of the software and computer are as follows:

- ArcView GIS Software – RM11,500
 - Stand-alone computer – RM 9,000
- TOTAL: RM20,500**

- (b) The pertinent Units (Lake & Wetlands, Environment, Hydrology) in the Perbadanan are required to evaluate, over a period of **6 months**, the usefulness of the low-level ICMS in facilitating their management of the Lake catchment and identify the items within the system where further refinements should be carried out to support their work.

- (c) Based on the evaluation the Perbadanan shall make a decision on whether to proceed to the next stage of the development of the low-level ICMS. If the Perbadanan decides to proceed with the next stage of the ICMS development it is recommended that the data and information in the low-level ICMS be converted to the SiCAD GIS system that has been adopted by the Perbadanan for its Sumber Putra System.

During the development of the low-level ICMS it was found that a lot of the data are quite “dirty” and it was not possible within the time-constraint and scope of work within the Study to do a thorough data cleaning exercise. Thus, the bulk of the work during the second phase of the ICMS development will be on data editing, data integration, data-clean-up and data verification. It will also involve refinements to the various components and databases in the low-level ICMS, based on the feedback from the respective Units using the low-level ICMS. The indicative consulting services costs for this second-phase is estimated to be about RM200,000.

- (d) Further developments of the ICMS system on the SiCAD GIS to include the various technological components, such as real-time water quality and hydrological data monitoring through telemetry, as described in the conceptual proposal for the complete ICMS in Appendix 7.4, can be carried out after another period of use of the refined low-level ICMS on the SiCAD GIS, by the pertinent Units. It is not possible at this stage of the Study to define the indicative cost for this stage of the ICMS development.
- (e) The Perbadanan should also consider creating a position for a Geographical Information Officer (GIO) within its IT Unit to handle all issues related to the managing of geo-referenced digital information within the Perbadanan. The Consultant understands that the Perbadanan has plans to recruit such a person in the near future.
- (f) To facilitate information sharing among the various government agencies, regulatory bodies and major stakeholders within the catchment it is recommended that the Perbadanan and the proposed Putrajaya Lake Catchment Management Committee agree on a clear set of objectives for data collection, updating and sharing among themselves.

APPENDIX 7.1

INFORMATION MANAGEMENT WITHIN PERBADANAN PUTRAJAYA

1.0 Administrative Structure, Responsibilities and Management

1.1 Within the context of the study, the technical units directly involved are grouped under the Landscape and Environment Division of the City Planning Department. They are:

- Hydrology Unit
- Environment Unit
- Lake Unit
- Horticultural Unit
- Landscape Unit

1.2 These units will be responsible for the environmental monitoring programmes, including data collection and processing. All programmes should have clearly defined management objectives and process paths.

1.3 If data is shared between units, then the procedures for sharing and the format should be stated. This may seem trivial when the units and the department are small, however, as their functions mature and routines are set, procedures become necessary to enable an audit trail.

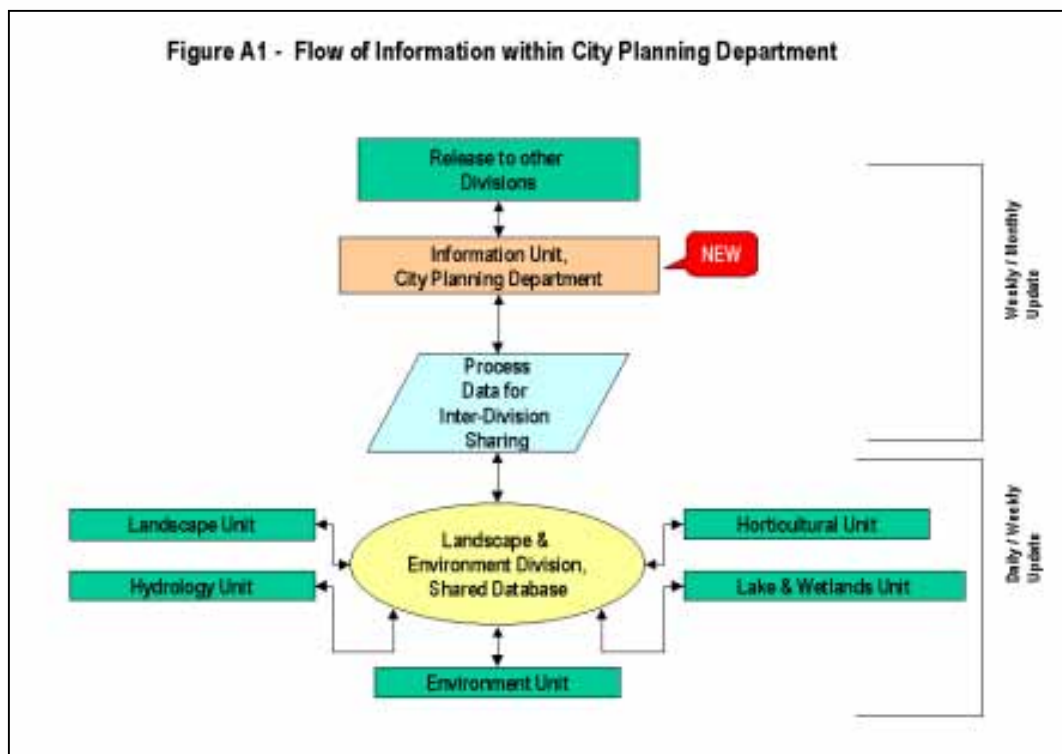
1.4 The custodian of digital data is the Information Technology Unit (ITU) under the Corporate Services Department. The ITU is responsible for the development and updating of all plans related to the development of Putrajaya. It plays a central role in maintaining electronic data relating to development and management of the city.

1.5 However, it is more appropriate if the Landscape and Environment Division manages its environmental database as the need for information amongst the units of the division are often immediate particularly in response to an environmental emergency.

1.6 Each department and unit of Perbadanan Putrajaya should be responsible for collecting, keying-in and updating their own maps

and datasets. However, this should be carried out in a co-ordinated manner so that they are not duplicating each other's efforts.

- 1.7 For example, the Town Planning Department should be responsible for creating and updating the cadastral and zoning basemaps. However, the valuation data is simply an attribute Oracle database maintained by the Valuation and Property Department, which is linked to the lot parcel maps.
- 1.8 It may thus be helpful if an Information Unit (IU) be created under each department as the intermediary to the ITU. A Geographic Information Officer (see section 4.1) will play a key role in the proper co-ordination of these efforts.
- 1.9 In summary, the role of the technical department's is to collect, process and manage their data in an agreed format whilst that of the ITU is to coordinate all relevant information for inter-departmental sharing and to develop official maps of the Putrajaya administrative and catchment area.



2.0 Information flow within the City planning Department

- 2.1 Figure A7.1 describes a proposed process for data flow between the units of the Landscape and Environment Division. It treats the

department as an independent organisation which contributes a certain level of data to the central ITU.

2.2 Initially, the amount of data and information to be processed may seem overbearing and some effort may be required to identify data/information pertinent to the day-to-day functions of the unit. The following are the proposed exercises:-

2.2.1 General Exercise - Identification of information requirements for

- (a) Divisional level – data in both raw and processed format; technical notes and analysis
- (b) Departmental level – processed and analysed data; with description of trends, technical reports
- (c) Board level – summarised information; statements of problems, alternative solutions and conclusions; management reports
- (d) Public level – officially endorsed documents, maps and digital data

2.2.2 Specific Exercises – The specific exercises are as follows:

- Identifying data sources to provide information to management
- Targeting monitoring programmes to produce information that achieve management needs
- Identification of resource persons at unit level and department level for data management and sharing
- Identification of actual data to be shared, its format and frequency of sharing (weekly updates, monthly updates)

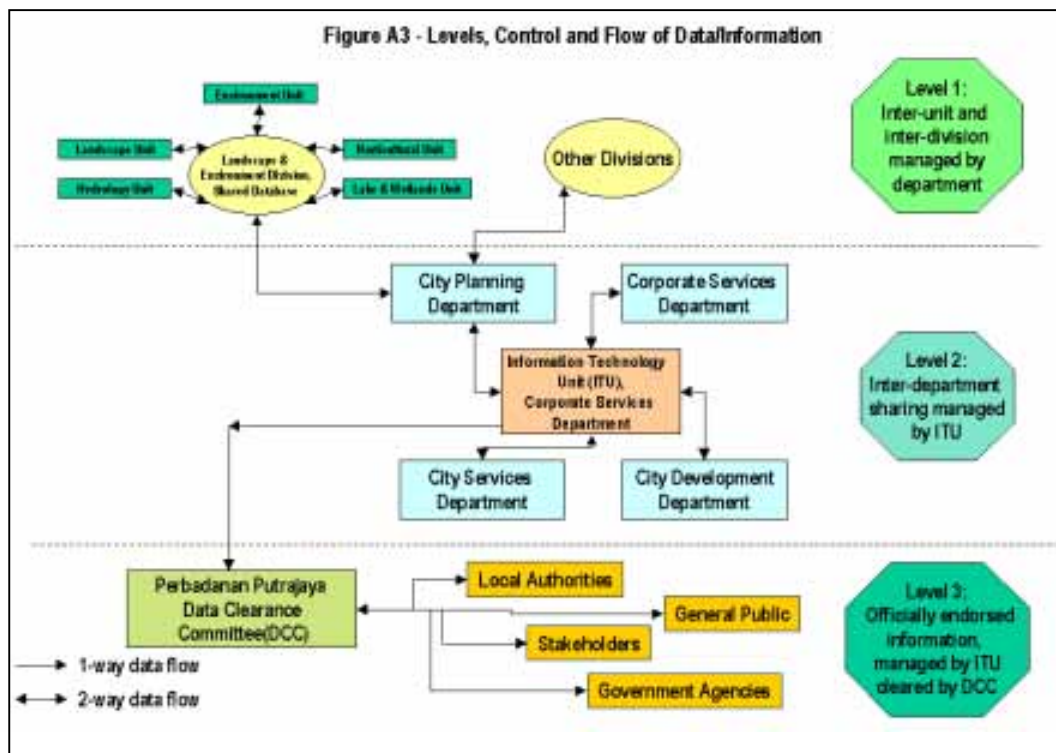
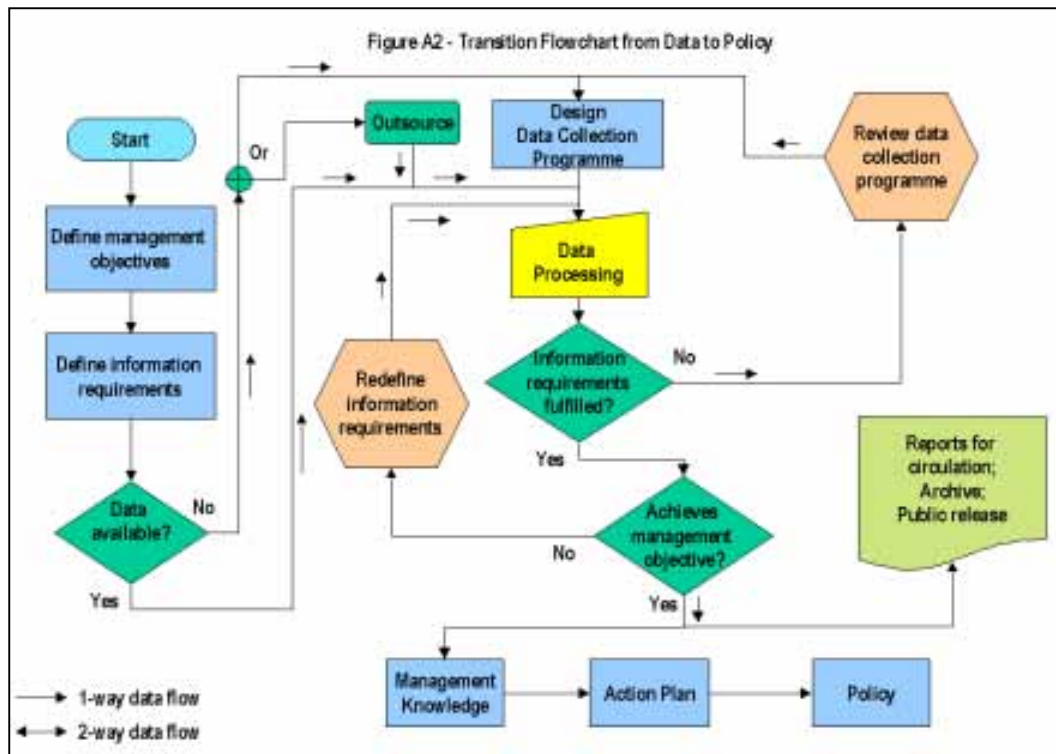
2.3 While the nature of work does not permit every information requirement to be anticipated, it is worthwhile to start by first identifying management objectives and subsequently identifying the information required to achieve the said objective. The information requirements will then lead to identification of data needed to be collected.

2.4 Some examples are tabulated below in Table A7.1:

Table A7.1 Management objectives and information requirement

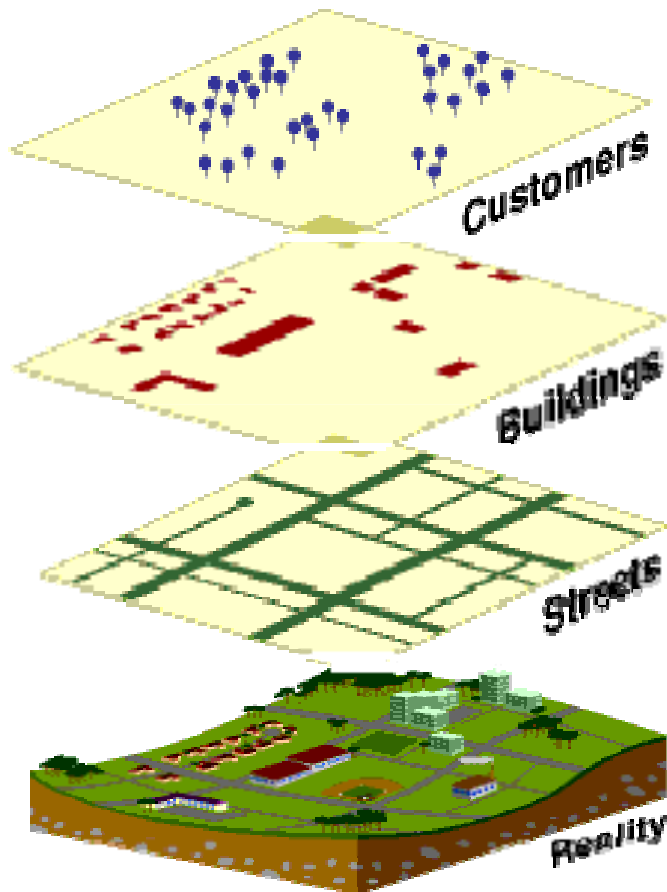
Management Objective	Information Required	Frequency of Submission	Data Source
To maintain water level at X meters in central lake	Water level at key points, Rainfall data, streamflow data	Daily	Hydrological stations (Lake & Wetlands Unit)
To maintain water quality in central lake within permitted levels	Water quality in lake, water quality at monitoring points	Weekly	Water quality monitoring stations, hydrological stations (Hydrology, Environment Unit)
To check pollutant levels from north west Sector	Parameter levels from GPT's along drain X, water quality at station Y, wetland Z	Monthly	Environment Unit, Lake & Wetlands Unit

- 2.5 The information requirements should later be improved if it does not meet the management objective. Similarly, if information is insufficient, the data collection programme should then be reviewed. Figure A7.2 illustrates the process.
- 2.6 The sharing of technical data between the various units, divisions and departments of Perbadanan Putrajaya will require control. This will allow each section of Perbadanan Putrajaya to manage information according to its hierarchical position.
- 2.7 Data sharing within divisions are handled at departmental level whereas inter-departmental sharing is managed by the ITU.
- 2.8 A data clearance committee can be formed if necessary to serve as a final check before information is released to the public. Figure A7.3 illustrates the structure of levels and controls of data within and outside Perbadanan Putrajaya.



3.0 The Use of Geographical Information Systems (GIS)

- 3.1 The usefulness of Geographical Information Systems in environmental monitoring have been widely accepted and is one of the reasons why an ICMS is recommended to accompany the Catchment Management and Development Plan.
- 3.2 SiCad is the GIS software used in Perbadanan Putrajaya's Sumber Putra central data management system. Future GIS applications, if purchased whether at Department or Unit level must ensure cross-compatibility. However, the need of the management must be defined in order to decide as to what level or platform of GIS.
- 3.3 Costs for GIS systems are expensive particularly, fully-interactive types. A complete Decision-Support System may require administrative adjustments for its proper upkeep and utilisation.
- 3.4 Most studies carried out as part of this project require maps to carry out its analysis. In a few of the studies, maps are the most important criteria e.g. drainage and sewerage, slope analysis and land use studies, all requires contour maps and land parcel maps.
- 3.5 By putting all the maps in digital format and keying in the associated data (or attributes as it is referred to in GIS parlance), the GIS becomes a powerful tool for data entry, storage and updates, data query and analysis and for producing hardcopy and softcopy maps and data output.
- 3.6 Gaining access to the study data from the GIS is also faster and easier, and maps provide a spatial perspective, which is impossible to achieve with spreadsheets and hardcopy reports. GIS technology also promote data sharing by encouraging consultants, decision makers and other endusers to utilise each other's data in order to carry out better and more powerful analysis.
- 3.7 Figure A7.4 shows the representation of real-world objects in GIS concepts.



- Computer mapping
- Information represented by points, lines, polygons and text
- Linked to multiple layers of databases
- Automated system for
 - Capture
 - Storage
 - Retrieval
 - Analysis
 - Display
 - Output

Figure A7.4 GIS Concepts

3.8 The main concerns in GIS implementation are maps and data, procedures and application development.

3.9 The factors to be considered for selection of a GIS software and system are: -

- The software choices of other parties which have information relevant to environment and catchment monitoring
- The risk of data loss between software types and versions particularly, the loss of topological data which will be time consuming to rectify.
- The availability of skilled personnel in the selected software
- The choice of operating system platform; a UNIX based GIS on a server system although being more powerful than a personal-computer (PC) or desktop system requires

appropriately trained and skilled personnel for support and development work

- The learning curve of the selected software; Unix based systems require longer training time as compared to PC systems.

4.0 Recommendation

4.1 Geographic Information Officer (GIO)

4.1.1 A Geographic Information Officer (GIO) is recommended to be part of Perbadanan Putrajaya's Information Technology management team. The task of the GIO is to formulate strategies that incorporate geographic information technology to improve the organisation's overall performance.

4.1.2 The GIO should be responsible for:

- Development of the geographic information plans and associated policies to achieve the strategic objectives of the organisation.
- Development of organisation-wide information product and technology requirements.
- Directing the investment of information technology funds to maximise organisation benefits and maintaining a managed portfolio of those investments.
- Providing external representation for the organisation on all matters relating to geographic information.
- Supporting the creation and management of the enterprise geographic data model with respect to content, standards, quality, geographic reference, integration, interoperability, and appropriate documentation, including metadata.
- Providing open access to data where appropriate and promoting sharing of commonly needed data resources, within Putrajaya, among other stakeholders in the catchment area and the public at large.

4.1.3 As with the Head of Information Technology, a GIO brings specialised skills to the organisation. A GIO has a comprehensive knowledge of geographically distributed phenomena and the processes that create and modify the geographic landscape. The GIO has knowledge of geographic information technologies and the digital representation of geographic phenomena, and has knowledge of the role of geospatial information in organisation-wide operations such as management, decision-making, and policy formulation.

4.1.4 A GIO should have an advanced degree in geographic information science, geography, remote sensing, computer science or a closely related field and has demonstrated GIS management experience.

4.2 Procedures for handling Digital Maps and Databases

4.2.1 Perbadanan Putrajaya is in a unique position to develop proper procedures for the handling of digital maps and databases as the whole Putrajaya City is being built from scratch.

4.2.2 Proper procedures need to be put in place in terms of:

- Electronic and hardcopy archiving – Who has responsibility? How often? Where? Firewall? Disaster and Recovery Centre? Archiving and circulation of hardcopy maps and documents?
- Responsibilities for maintenance and updates of different databases. This is best addressed by allowing different departments to be responsible for their own datasets whilst not duplicating each other's efforts.
- Access and Security issues need to be properly addressed so that only authorised personnel are given access to sensitive documents, whilst not hindering the promotion of data sharing concept.

4.3 Conversion of CAD datasets to GIS Format

4.3.1 The CAD datasets submitted by various outside parties (developers, planners, and landowners) in the Sumber

Putra Project are recommended to be converted into GIS format. This will allow them to be integrated to the GIS data repository in the GIS Server.

4.3.2 Over time, these integrated GIS digital maps and data will become an invaluable resource to Putrajaya.

4.4 Data Sharing through Intranet (Internal Access) and Internet Map Server (External Access)

4.4.1 Staff within Perbadanan Putrajaya should undergo training not only on GIS software and concepts but also on the maps and datasets in the GIS Server so that they have a deep understanding of available resources. Each department should be given access to the GIS Server (but not necessarily “editing” access) via a corporate Intranet.

4.4.2 Furthermore, certain information, which might be of use and concern to the public, should be made available via the Internet Map Server. These could be the general cadastral, planning, topographical and zoning information, which could be useful to developers, for instance, in their preparation of proposed Development Master Plans or Layout Plans. Currently, they would need to obtain this information over the counter from various public institutions.

4.5 Develop and Integrate Specific GIS Applications for All Departments within Putrajaya

4.5.1 GIS can be utilised by the Town Planning Department, the I.T. Department, the Licensing Department, the Building Department, the Valuation and Property Department, the Engineering Department, the Customer Services Department, the Irrigation and Drainage Department, and the Perbadanan Putrajaya management.

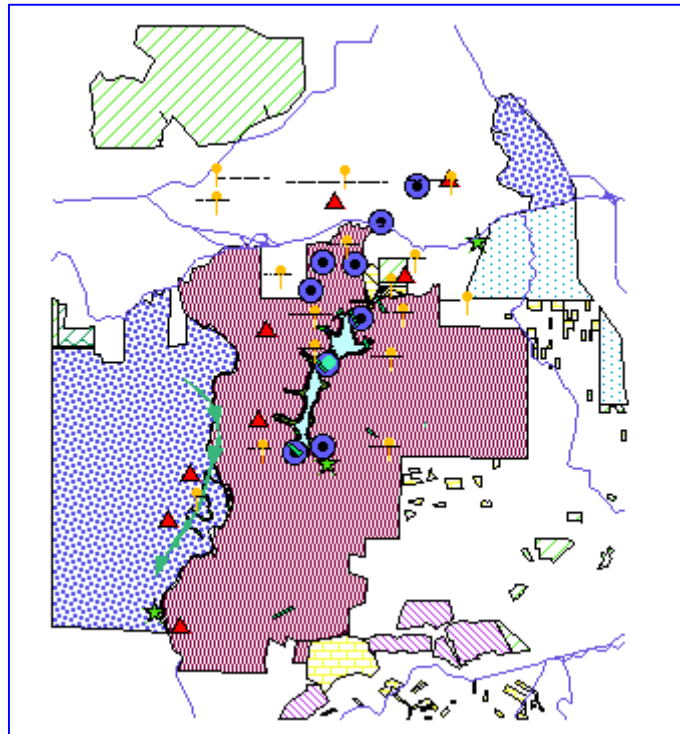
4.5.2 However, most of the time, the endusers do not necessarily want to, or have the time to undergo proper training to become proficient users in GIS. Then there are users who only need to use some basic GIS functionality coupled with their own datasets or maps.

- 4.5.3 For all these users, the power of GIS technology can be harnessed so that they can utilise fully their maps and databases by developing small, specific applications using a combination of MapObjects, Visual Basic and/or Visual C++, to suit their individual department's requirements.
- 4.5.4 Finally, document imaging is a widely available and used tool in Malaysia today. However, document imaging linked to the GIS is a new area and requires proper expertise and careful planning before implementation. This can be an extremely useful tool for planners, engineers and managers as they can zoom onto an area using the GIS and retrieve whatever scanned images of engineering plans and drawings available within the area (especially underground utilities).

APPENDIX 7.2

Catchment Development and Management Plan for Putrajaya Lake

Data Description for the ICMS (Version 1)



Produced by:



Head Office:

No: 35, 1st & 2nd Floor
Jalan USJ 10/1
47620 UEP Subang Jaya
Selangor Darul Ehsan, MALAYSIA
Tel: (603) 734 4197
Fax: (603) 733 7142
E-mail: razali@malsat.com.my

Branch Office:

Lot 442, No. 8, 2nd Floor
Jalan Rubber
93400 Kuching
Sarawak, MALAYSIA
Tel: (6082) 236 310
Fax: (6082) 236311

Website: <http://www.malsat.com.my>

Installation

For your convenience, the data description for the ICMS for the **Catchment Development and Management Plan for Putrajaya Lake** Version 1.0 is delivered to you in the following data formats: -

- ArcView Native Format (*.SHP)

The datasets are stored in a single 100Mb Zip Disk or eight 1.44Mb 3.5” diskettes, or other suitable digital data medium. Where necessary, especially DXF files, they are compressed using the PKZIP.EXE utility. These can be uncompressed using a WINZIP shareware which is included in the Zip Disk or in the 3.5” diskette No. 8. The WINZIP shareware has a PKUNZIP.EXE utility for compressing/decompressing data. Please register the WINZIP shareware with the copyright owner.

Data Delivered

All the data delivered was installed in a GIS Unix Server under logical path (“**database\dg_map\professional\putrajaya**”). Under the folder of **\putrajaya**, there are 11 more sub-folders, which indicates the type of features, which is included in this delivery:

1. **\putrajaya \Pollution_Source_Study**
2. **\putrajaya \Mini_Wetland_Study**
3. **\putrajaya \Water_Quality_Study**
4. **\putrajaya \Hydrological_Study**
5. **\putrajaya \Erosion&Sedimentation_Study**
6. **\putrajaya \Geological&Hydrological_Study**
7. **\putrajaya \Drainage_Master_Plan**
8. **\putrajaya \Sewarage_Master_Plan**
9. **\putrajaya \Existing_Landuse**
10. **\putrajaya \Landuse_Master_Plan**
11. **\putrajaya \Features**

Layers

There are 46 ArcView Shape (*.shp) files.

Layer Code	Filename	Description	Entity Type
1	ROAD	Road Network	Polygon
2	RIVERLINE	River	Line
3	RIVERPOLY	River	Polygon
4	DAM	Dam	Polygon
5	LAKE	Lake	Polygon
6	PHIGHWAY	Plus Highway	Line
7	PEXLINK	Proposed Express Link	Line
8	WETLAND	Wetland area	Polygon
10	CONLINE	Contour Lines	Polyline
12	CONTEXT	Contour lines text/description	Text
14	RCASE	Road Case	Polygon
16	MASPLAN	Master Plant (Combination all layers)	Pgon/Pline/Pt/tx
17	LOT	Lots	Polygon
18	PUTLACAT	Putrajaya Lake Catchment	Polygon
20	PUTBOUND	Putrajaya Boundary	Polygon
21	SGCHAUB	Boundary of Sg Chua catchment area	Polygon
22	DISTBOUN	District Boundary	Polygon
23	WEIRCW	Weir in center wetland	Polygon
24	SWAMFZCW	Swamp Forest Zone in center wetland	Polygon
25	PONDWCW	Pond in center wetland	Polygon
26	MARSHCW	Marsh in center wetland	Polygon
27	WEIRPL	Weir in center Primary Lake	Polygon
28	SWAMPL	Swamp Forest Zone in center P. Lake	Polygon
29	PONDPL	Pond in center Primary Lake	Polygon
30	MARSHPL	Marsh in center Primary Lake	Polygon
31	SYNCLINE	Geology - Syncline	Point
32	KENNYHF	Geology – Kenny Hill Formation	Polygon
33	HAWTFOR	Geology – Hawthornden Formation	Polygon
34	ALLUVIUM	Geology – Alluvium	Polygon
35	FRACTURE	Geology – Fractures - Lineaments	Line
36	ANTICLIN	Geology - Anticline	Point
37	DETPOND	Detention Ponds	Point
38	VEGEBUF	Vegetation buffer	Point
39	KENNYHI2	Kenny Hill Formation 2	Point
40	HAWTHO2	Hawthornden Formation 2	Point
41	WELLPRO	Existing Production wells	Point
42	ALLUVIU2	Alluvium 2	Point
43	RSTATION	Rainfall Station	Point
44	SFSTATIO	Stream flow station	Point
45	WQSATIO	Water Quality Station	Point
46	STPLANT	Sewerage Treatment Plant	Point

47	SDRAIN	Surface Drainage Direction	Line
48	CATCHA	Putrajaya catchment area	Polygon
49	WETLAND	Wetland	Polygon
50	ERL_CENT	Erl_cent	Line
51	LANDUSE	Land use	Polygon
52	PIEZOME	Piezometer	Point

Accuracy

The expected accuracy is +/- 15 meters. This needs to be verified by collecting GPS points at road intersections or other landmarks.

Map Projection

All data were from various sources with different map projections, i.e. Lat./Long (Malaysia) and MRSO. Additional data were obtained by field GPS Survey in the WGS84 coordinate system but the final digital data products were merged in a single MRSO ((West Malaysia) projection only.

Attributes

Apart from their respective individual attributes, e.g. street name for ROAD, all features or GIS layers has four common attributes:

- Map Source - Coded to reflect either topographical maps, town maps, Aerial Photography, or other sources.
- Map Projection - Of the map source, NOT the projection of the Digital Data.
- Map Scale - Of the map source, NOT the projection of the Digital Data
- Last Updated - Date of last map and data update by MALSAT's Technical Department, NOT the currency of the map sources.

Where certain information is not available, the attributes are entered as "N/A". For example, an attribute for a road with the entry "N/A" means that after field verification the road has no name.

Spatial Database Structure

Layer Code 1: Structure for table ROAD

Field	Field Name	Type	Width	Dec
1	Layer_Code	Character	2	
2	Name	Character	30	
3	Map_Source	Character	10	
4	Map_Scale	Character	10	
5	Map_Projection	Character	50	
6	Last_Updated	Character	10	

Layer Code 2: Structure for table RIVERLINE

Field	Field Name	Type	Width	Dec
1	Layer_Code	Character	2	
2	Name	Character	30	
3	Map_Source	Character	10	
4	Map_Scale	Character	10	
5	Map_Projection	Character	50	
6	Last_Updated	Character	10	

Layer Code 3: Structure for table RIVERPOLY

Field	Field Name	Type	Width	Dec
1	Layer_Code	Character	2	
2	Name	Character	30	
3	Map_Source	Character	10	
4	Map_Scale	Character	10	
5	Map_Projection	Character	50	
6	Last_Updated	Character	10	

Layer Code 4: Structure for table DAM

Field	Field Name	Type	Width	Dec
1	Layer_Code	Character	2	
2	Name	Character	30	
3	Map_Source	Character	10	
4	Map_Scale	Character	10	
5	Map_Projection	Character	50	
6	Last_Updated	Character	10	

Layer Code 5: Structure for table LAKE

Field	Field Name	Type	Width	Dec
1	Layer_Code	Character	2	
2	Name	Character	35	
3	Description	Character	25	
4	Map_Source	Character	10	
5	Map_Scale	Character	10	
6	Map_Projection	Character	50	
7	Last_Updated	Character	10	

Layer Code 6: Structure for table PHIGHWAY

Field	Field Name	Type	Width	Dec
1	Layer_Code	Character	2	
2	Name	Character	30	
3	Map_Source	Character	10	
4	Map_Scale	Character	10	
5	Map_Projection	Character	50	
6	Last_Updated	Character	10	

Layer Code 7: Structure for table PEXLINK

Field	Field Name	Type	Width	Dec
1	Layer_Code	Character	2	
2	Name	Character	30	
3	Map_Source	Character	10	
4	Map_Scale	Character	10	
5	Map_Projection	Character	50	
6	Last_Updated	Character	10	

Layer Code 8: Structure for table WETLAND

Field	Field Name	Type	Width	Dec
1	Layer_Code	Character	2	
2	Map_Source	Character	10	
3	Map_Scale	Character	10	
4	Map_Projection	Character	50	
5	Last_Updated	Character	10	

Layer Code 10: Structure for table CONLINE

Field	Field Name	Type	Width	Dec
1	Layer_Code	Character	2	
2	Elevation	Number	10	
3	Map_Source	Character	10	
4	Map_Scale	Character	10	
5	Map_Projection	Character	50	
6	Last_Updated	Character	10	

Layer Code 12: Structure for table CONTEXT

Field	Field Name	Type	Width	Dec
1	Contour Info	Character	50	

Layer Code 14: Structure for table RCASE

Field	Field Name	Type	Width	Dec
1	Layer_Code	Character	2	
2	Road_Name	Character	30	
3	Map_Source	Character	10	
4	Map_Scale	Character	10	
5	Map_Projection	Character	50	
6	Last_Updated	Character	10	

Layer Code 16: Structure for table MASPLAN

Field	Field Name	Type	Width	Dec
1	Layer_Code	Character	2	
4	Map_Source	Character	10	
5	Map_Scale	Character	10	
6	Map_Projection	Character	50	
7	Last_Updated	Character	10	

Layer Code 17: Structure for table LOT

Field	Field Name	Type	Width	Dec
1	Layer_Code	Character	2	
2	Lot No	Character	10	
3	Map_Projection	Character	20	
4	Map_Source	Logical		
5	Map_Scale	Character	10	
6	Last_Updated	Character	10	

Layer Code 18: Structure for table PUTLACAT

Field	Field Name	Type	Width	Dec
1	Layer_Code	Character	2	
2	Feature_Name	Character	50	
3	Map_Source	Character	10	
4	Map_Scale	Character	10	
5	Map_Projection	Character	50	
6	Last_Updated	Character	10	

Layer Code 20: Structure for table PUTBOUND

Field	Field Name	Type	Width	Dec
1	Layer_Code	Character	2	
2	Feature_Name	Character	50	
3	Map_Source	Character	10	
4	Map_Scale	Character	10	
5	Map_Projection	Character	50	
6	Last_Updated	Character	10	

Layer Code 21: Structure for table SGCHAUB

Field	Field Name	Type	Width	Dec
1	Layer_Code	Character	2	
2	Feature_Name	Character	50	
3	Map_Source	Character	10	
4	Map_Scale	Character	10	
5	Map_Projection	Character	50	
6	Last_Updated	Character	10	

Layer Code 22: Structure for table DISTBOUN

Field	Field Name	Type	Width	Dec
1	Layer_Code	Character	2	
2	Feature_Name	Character	50	
3	Map_Source	Character	10	
4	Map_Scale	Character	10	
5	Map_Projection	Character	50	
6	Last_Updated	Character	10	

Layer Code 23: Structure for table WEIRCW

Field	Field Name	Type	Width	Dec
1	Layer_Code	Character	2	
2	Feature_Name	Character	50	
3	TCom_Code	Character	2	
4	Map_Source	Character	10	
5	Map_Scale	Character	10	
6	Map_Projection	Character	50	
7	Last_Updated	Character	10	

Layer Code 24: Structure for table SWAMZCW

Field	Field Name	Type	Width	Dec
1	Layer_Code	Character	2	
2	Feature_Name	Character	50	
3	TCom_Code	Character	2	
4	Map_Source	Character	10	
5	Map_Scale	Character	10	
6	Map_Projection	Character	50	
7	Last_Updated	Character	10	

Layer Code 25: Structure for table PONDCW

Field	Field Name	Type	Width	Dec
1	Layer_Code	Character	2	
2	Feature_Name	Character	50	
3	Map_Source	Character	10	
4	Map_Scale	Character	10	
5	Map_Projection	Character	50	
6	Last_Updated	Character	10	

Layer Code 26: Structure for table MARSHCW

Field	Field Name	Type	Width	Dec
1	Layer_Code	Character	2	
2	Feature_Name	Character	50	
3	Map_Source	Character	10	
4	Map_Scale	Character	10	
5	Map_Projection	Character	50	
6	Last_Updated	Character	10	

Layer Code 27: Structure for table WEIRPL

Field	Field Name	Type	Width	Dec
1	Layer_Code	Character	2	
2	Feature_Name	Character	50	
3	Map_Source	Character	10	
4	Map_Scale	Character	10	
5	Map_Projection	Character	50	
6	Last_Updated	Character	10	

Layer Code 28: Structure for table SWAMPL

Field	Field Name	Type	Width	Dec
1	Layer_Code	Character	2	
2	Feature_Name	Character	50	
3	Map_Source	Character	10	
4	Map_Scale	Character	10	
5	Map_Projection	Character	50	
6	Last_Updated	Character	10	

Layer Code 29: Structure for table PONDPL

Field	Field Name	Type	Width	Dec
1	Layer_Code	Character	2	
2	Feature_Name	Character	50	
3	Map_Source	Character	10	
4	Map_Scale	Character	10	
5	Map_Projection	Character	50	
6	Last_Updated	Character	10	

Layer Code 30: Structure for table MARSHPL

Field	Field Name	Type	Width	Dec
1	Layer_Code	Character	2	
2	Feature_Name	Character	50	
3	Map_Source	Character	10	
4	Map_Scale	Character	10	
5	Map_Projection	Character	50	
6	Last_Updated	Character	10	

Layer Code 31: Structure for table SYNCLINE

Field	Field Name	Type	Width	Dec
1	Layer_Code	Character	2	
2	Feature_Name	Character	50	
3	Map_Source	Character	10	
4	Map_Scale	Character	10	
5	Map_Projection	Character	50	
6	Last_Updated	Character	10	

Layer Code 32: Structure for table KENNYHF

Field	Field Name	Type	Width	Dec
1	Layer_Code	Character	2	
2	Feature_Name	Character	50	
3	Map_Source	Character	10	
4	Map_Scale	Character	10	
5	Map_Projection	Character	50	
6	Last_Updated	Character	10	

Layer Code 33: Structure for table HAWTFOR

Field	Field Name	Type	Width	Dec
1	Layer_Code	Character	2	
2	Feature_Name	Character	50	
3	Map_Source	Character	10	
4	Map_Scale	Character	10	
5	Map_Projection	Character	50	
6	Last_Updated	Character	10	

Layer Code 34: Structure for table FRACTURE

Field	Field Name	Type	Width	Dec
1	Layer_Code	Character	2	
2	Feature_Name	Character	50	
3	Map_Source	Character	10	
4	Map_Scale	Character	10	
5	Map_Projection	Character	50	
6	Last_Updated	Character	10	

Layer Code 35: Structure for table ANTICLIN

Field	Field Name	Type	Width	Dec
1	Layer_Code	Character	2	
2	Feature_name	Character	50	
3	Map_Source	Character	10	
4	Map_Scale	Character	10	
5	Map_Projection	Character	50	
6	Last_Updated	Character	10	

Layer Code 36: Structure for table ALLUVIUM

Field	Field Name	Type	Width	Dec
1	Layer_Code	Character	2	
2	Feature_name	Character	50	
3	Map_Source	Character	10	
4	Map_Scale	Character	10	
5	Map_Projection	Character	50	
6	Last_Updated	Character	10	

Layer Code 37: Structure for table DETPOND

Field	Field Name	Type	Width	Dec
1	Layer_Code	Character	2	
2	Feature_name	Character	50	
3	Map_Source	Character	10	
4	Map_Scale	Character	10	
5	Map_Projection	Character	50	
6	Last_Updated	Character	10	

Layer Code 38: Structure for table VEGEBUF

Field	Field Name	Type	Width	Dec
1	Layer_Code	Character	2	
2	Feature_name	Character	50	
3	Map_Source	Character	10	
4	Map_Scale	Character	10	
5	Map_Projection	Character	50	
6	Last_Updated	Character	10	

Layer Code 39: Structure for table KENNYHF2

Field	Field Name	Type	Width	Dec
1	Layer_Code	Character	2	
2	Feature_name	Character	50	
3	Map_Source	Character	10	
4	Map_Scale	Character	10	
5	Map_Projection	Character	50	
6	Last_Updated	Character	10	

Layer Code 40: Structure for table HAWTHO2

Field	Field Name	Type	Width	Dec
1	Layer_Code	Character	2	
2	Feature_name	Character	50	
3	Map_Source	Character	10	
4	Map_Scale	Character	10	
5	Map_Projection	Character	50	
6	Last_Updated	Character	10	

Layer Code 42: Structure for table ALLIVIU2

Field	Field Name	Type	Width	Dec
1	Layer_Code	Character	2	
2	Feature_name	Character	50	
3	Map_Source	Character	10	
4	Map_Scale	Character	10	
5	Map_Projection	Character	50	
6	Last_Updated	Character	10	

Layer Code 43: Structure for table RSTATION

Field	Field Name	Type	Width	Dec
1	Layer_Code	Character	2	
2	Feature_name	Character	50	
3	Map_Source	Character	10	
4	Map_Scale	Character	10	
5	Map_Projection	Character	50	
6	Last_Updated	Character	10	

Layer Code 44: Structure for table SFSTATION

Field	Field Name	Type	Width	Dec
1	Layer_Code	Character	2	
2	Feature_Name	Character	50	
3	Map_Source	Character	10	
4	Map_Scale	Character	10	
5	Map_Projection	Character	50	
6	Last_Updated	Character	10	

Layer Code 45: Structure for table WQSATIO

Field	Field Name	Type	Width	Dec
1	Layer_Code	Character	2	
2	Feature_Name	Character	50	
3	Map_Source	Character	10	
4	Map_Scale	Character	10	
5	Map_Projection	Character	50	
6	Last_Updated	Character	10	

Layer Code 46: Structure for table STPLANT

Field	Field Name	Type	Width	Dec
1	Layer_Code	Character	2	
2	Feature_Name	Character	50	
3	Map_Source	Character	10	
4	Map_Scale	Character	10	
5	Map_Projection	Character	50	
6	Last_Updated	Character	10	

Layer Code 47: Structure for table SDRAIND

Field	Field Name	Type	Width	Dec
1	Layer_Code	Character	2	
2	Feature_Name	Character	50	
3	Map_Source	Character	10	
4	Map_Scale	Character	10	
5	Map_Projection	Character	50	
6	Last_Updated	Character	10	

Layer Code 48: Structure for table CATCHA

Field	Field Name	Type	Width	Dec
1	Layer_Code	Character	2	
2	Feature_Name	Character	50	
3	Map_Source	Character	10	
4	Map_Scale	Character	10	
5	Map_Projection	Character	50	
6	Last_Updated	Character	10	

Layer Code 49: Structure for table WETLAND

Field	Field Name	Type	Width	Dec
1	Layer_Code	Character	2	
2	Feature_Name	Character	50	
3	Map_Source	Character	10	
4	Map_Scale	Character	10	
5	Map_Projection	Character	50	
6	Last_Updated	Character	10	

Layer Code 50: Structure for table ERL_CENT

Field	Field Name	Type	Width	Dec
1	Layer_Code	Character	2	
2	Feature_Name	Character	50	
3	Map_Source	Character	10	
4	Map_Scale	Character	10	
5	Map_Projection	Character	50	
6	Last_Updated	Character	10	

Layer Code 51: Structure for table PIEZOM

Field	Field Name	Type	Width	Dec
1	Layer_Code	Character	2	
2	Feature_Name	Character	50	
3	Map_Source	Character	10	
4	Map_Scale	Character	10	
5	Map_Projection	Character	50	
6	Last_Updated	Character	10	

Layer Code 52: Structure for table LANDUSE

Field	Field Name	Type	Width	Dec
1	Layer_Code	Character	2	
2	Feature_Name	Character	50	
3	Map_Source	Character	10	
4	Map_Scale	Character	10	
5	Map_Projection	Character	50	
6	Last_Updated	Character	10	

APPENDIX 7.3

DATABASE MANUAL FOR LOW-LEVEL ICMS



PREPARED BY

National Hydraulic Research Institute Malaysia (NAHRIM)

Water Quality Database : WaterQuality.mdb

Purpose: This database is designed for the storage of in-situ water quality data

End-user: Environmental Management Unit , Lake Management Unit

Background

The water quality database and data tables allows for the prompt record of field water quality measurements. The data tables are tailored to accompany the water quality monitoring programme as proposed in the Putrajaya Lake Management Guide. The water quality parameters proposed to be measured are:

1. PH value
2. Dissolve Oxygen (DO)
3. Suspended Solids (SS)
4. Total Phosphorous (TP)
5. Reactive Phosphorous (RP)

Description

The database comprises four tables and is discussed below:

- *Thresh* – the table containing threshold data for effluent parameters based on the Environmental Quality Act, 1974. This table is a table of standards. It is primarily static and updates of this table is expected to accompany legislative changes to the national or local water quality standards. It's function is to provide the facility for queries involving comparisons between field data recorded in the other water quality datatables with the current standards. The structure of this table has been extracted from Appendix 16 of the Putrajaya Environmental Management Guide – *Second Schedule; Environmental Quality Act, 1974; Environmental Quality (Perbadanan Putrajaya) (Water Pollution Control) Regulations, 1998 [Regulations 8(1), 8(2)]; Parameter Limits of Effluent*
- *WQStation* - the table containing information pertaining to the station location, description and management. This data table provides the GIS link to planning maps.
- *WQJob* – the data table containing information regarding the sampling assignment or job. This table is used to record weather conditions, site notes and dates of sampling. This table can be copied and named after the actual stations once they are established.
- *WQSample* – the sampling data table that is used to record sampling times, depths and readings for the various water quality parameters tested. This table can be copied and named after the actual stations once they are established.

The three data tables can be linked by the primary key fields (i) the Station ID and (ii) the Sampling Job Number. The Station ID (primary key) links table WQStation to WQJob, the former providing the geographical reference to the actual water quality measurements. The Sampling Job Number links the field assignment records in WQJob to the measurements at various depths recorded in WQSample

WATERQUALITY

Datatable: WQStation

	Field Name	Data Type	
🔑	Sta_ID	Text	Water quality station ID number (unique)
	Sta_Desc	Memo	Description of station location
	Lat	Number	Latitude of location in degrees MR50
	Long	Number	Longitude of location in degrees MR50
	Sta_Date	Date/Time	Date of station set-up and first sampling
	Maint_by	Text	Maintained by
	Notes	Memo	

Datatable: WQJob

	Field Name	Data Type	
🔑	Sta_ID	Text	Station ID
🔑	S_JobID	Text	Sampling job number
	S_Date	Date/Time	Date of sampling
	Wth	Text	Weather condition
	S_By	Text	Initial of person doing sampling
	Field_N	Memo	Notes of field activity

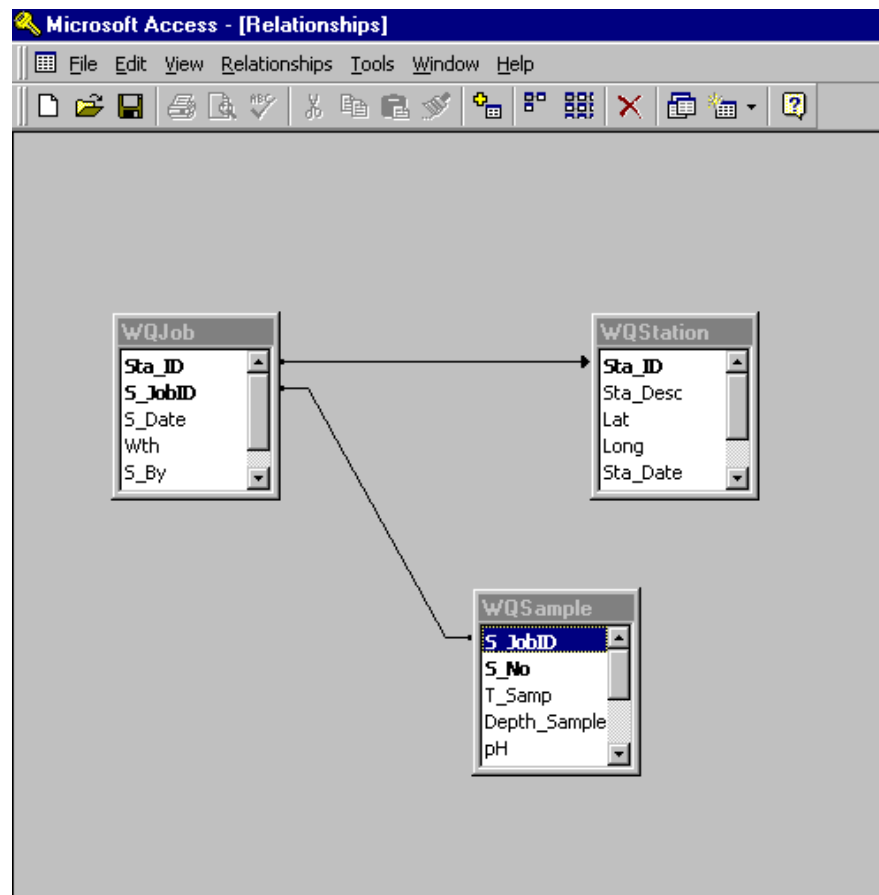
Datatable: WQSample

	Field Name	Data Type	
🔑	S_JobID	Text	Sampling job number
🔑	S_No	Text	Sample number
	T_Samp	Date/Time	Time of sampling
	Depth_Sample	Number	Depth of sampling in meters
	pH	Number	pH value of water sample
	DO	Number	Dissolved oxygen, mg/l
	TSS	Number	Total Suspended solids, mg/l
	TP	Number	Total Phosphorous, mg/l
	RP	Number	Reactive Phosphorous, mg/l

Relationship between Datatables in the WaterQuality Database

For field water quality parameter data entry, a form has been designed using the WQJob and WQSample datatables. The form consists of a main form, WQJob, and a subform, WQSample. This form allows data entry into both the datatables whereby each sampling job assignment and each sample can be recorded. It is important that the job ID and the sample ID be unique.

In order for such a form to be designed, the tables WQJob and WQSample must first be connected using the relationships feature in Microsoft Access. The relationships are as shown below.



The fields in bold have been designated as primary keys within each datatable. The relationship between WQStation and WQJob and between WQJob and WQSample is termed a “one-to-many” relationship. This means that for each station there can be more than one sampling job assignment and for each sampling job assignment there can be several samples.

Water Quality Parameter Data Entry Form

The Water Quality Parameter Data Entry Form is displayed below:

Form: WQJob

The screenshot displays the Microsoft Access interface for the 'WQJob' form. The title bar reads 'Microsoft Access - [WQJob]'. The main window has a blue header with the text 'PUTRAJAYA LAKE CATCHMENT AREA' and 'Water Quality Parameter Data Entry Form'. Below the header, there are several input fields: 'Station ID' (value: ub10), 'Sampling Job ID' (value: ub10-1), 'Sampling Date' (value: 13-05-99), 'Weather' (value: Fine), and 'Sampled By' (value: nhg). A 'Field Notes' text area contains the word 'okay'. Below these fields is a subform titled 'WQSample' which contains a table with the following data:

Sample No.	Time (hr:min)	Sampling Depth (m)	pH	DO	TSS	P (total)	P (reactive)
x1	09:00	1	6	11	22	33	44
x2	10:00	1.5	7	22	33	44	55

At the bottom of the form, there is a footer with the text 'DEVELOPMENT AND MANAGEMENT PLAN FOR PUTRAJAYA LAKE' and 'MAY 1999'. The status bar at the very bottom indicates 'Dissolved oxygen, mg/l'.

This form actually comprises of the main form WQJob and the subform WQSample. Entry of data will fill both the WQJob and WQSample datatables simultaneously due to the relationship set as explained earlier. Changes to the design of the subform can only be done by opening the subform independently.

Hydrology Database

Purpose: This database is designed for the storage of hydrological station information

End-user: Hydrology Unit

Background


This database is designed for hydrological information.

Description

HydStation: Datatable for location of hydrological stations i.e. for rainfall, evaporation or streamflow gauging stations. Geographical coordinates in the datatable connect the database with the relevant GIS map.

The HydStation table structure and form are shown below. The form is an alternative way to enter and also to view data.

Datatable: HydStation

	Field Name	Data Type	
	ID	AutoNumber	
	HSta_ID	Text	Station ID
	HSta_type	Text	Type of station
	HSta_Loca	Text	Location and description of station
	Equip_type	Text	Equipment type
	Lat	Number	Latitude of location in degrees MR50
	Long	Number	Longitude of location in degrees MR50
	St_Date	Date/Time	Date of station set-up and first sampling
	Cl_date	Date/Time	Date of closing station
	Maint_by	Text	Maintained by

Form: HydStation Data Entry/Viewing Form

The screenshot shows a Microsoft Access database window titled "Microsoft Access - [HydStation]". The main form area is titled "PUTRAJAYA LAKE CATCHMENT" and "HYDROLOGICAL STATIONS". The form contains the following fields:

Station ID	200112
Station Type	Rainfall
Location	Ladang Galway
Equipment type	manual
Latitude	2.8938
Longitude	101.6632
Start date	
Date date	
Maintained by	

At the bottom of the form, there is a footer section with the text: "DEVELOPMENT AND MANAGEMENT PLAN FOR PUTRAJAYA LAKE" and "NOV-98 1999". The status bar at the bottom shows "Record: 1 of 1" and "Station ID".

Drainage Database

Purpose: *This is a drainage structure information database. It is to be linked with the proposed drainage master plan drawing. The database will be associated with the line entities representing drainage structures.*

End-user: *Hydrology Unit, Environmental Unit*

Background

The drainage database provides the user with information on location and size of drains corresponding to a line feature on the GIS map.

Description

A drainage master plan is one of the deliverables of the study and the expected final recommendation presentation will include a drainage plan. The plan will indicate the layout of the proposed drains within the Putrajaya administrative area. The drainage database comprises 5 tables described below.

Drain1: this datatable will complement the final drainage map by displaying information on the drain type, size and maximum discharge including length and slope at the click of a button.

GPT1: this datatable is stores the inventory of gross pollutant traps installed in the drainage system

GPT_DControl: this datatable stores information on the gross pollutant traps designed as part of the drainage plan including design parameters and dimensions. GPTs are man-made structures constructed as part of the drainage system. As the name implies, its function is to trap all visible pollutants including rubbish, sediment and debris. GPTs have to be cleaned and maintained. GPT's are often built based on trial-and-error and may need to be redesigned to meet efficiency requirements designs. The last record in this data table represents the current design.

GPT_WQ1: is the water quality data table associated with the GPT station. It keeps the records of suspended solids measurements entering and exiting the GPT. A query programme can be designed to calculate the efficiency of the structure based on the measurements recorded here and provides a status report of the GPT. This will make fields DesMaxEff and Eff_MinVar fields redundant. Alternatively, the information can be exported to a spreadsheet for further analytical purposes.

DetPond1: Eight areas within the Putrajaya area have been designated as permanent flood detention ponds. Outside the Putrajaya area, five areas have been found to be potential sites for flood detention ponds. DetPond1 is a datatable for detention ponds found in the Putrajaya catchment. Information provided therein includes the sub-catchments in which they are located as well as the size and width of the ponds.

Datatable: Drain1

	Field Name	Data Type	
?	Dr_ID	Text	Drain structure ID (unique)
	Dr_type	Text	Type of drain; earth, concrete
	Slope	Number	Slope of drain X (horizontal):1(vertical)
	Length	Number	Length of drain in meters
	Qmax	Number	Maximum discharge in cubic meters per second
	Dr_pix	OLE Object	Linked graphic; design cross-section of typical drain

Datatable: GPT1

	Field Name	Data Type	
?	ID	AutoNumber	
	GPT_ID	Text	GPT unique identifier
	GPT_Desc	Memo	Description of GPT location
	Lat	Number	Latitude of location in degrees MR50
	Long	Number	Longitude of location in degrees MR50
	St_Date	Date/Time	Date of GPT construction
	Maint_by	Text	Maintained by
	Notes	Text	

Datatable: GPT_DControl

	Field Name	Data Type	Description
▶	ID	AutoNumber	
	GPT_ID	Text	GPT unique identifier
	GPT_ModNo	Text	Gross Pollutant Trap Modification ID number (unique)
	SubCatch	Text	Subcatchment
	Type	Text	Type description
	Maint_Per	Number	Maintenance period in months
	Date_Built	Date/Time	Date GPT was built
	ARI	Number	Design Average Recurrence Interval in years
	AreaRatio	Number	Area ratio in sq. meters/ ha.
	TrapWidth	Number	Maximum width of trap in meters
	TrapDepth	Number	Maximum depth of trap in meters
	DepthWeir	Number	Maximum depth to weir in meters
	DepthInlet	Number	Maximum depth to invert of inlet pipe, meters
	VelMax	Number	Maximum 1 year velocity in m/s
	Eff_Max	Number	Maximum efficiency for low discharge 25% quartile
	DesMaxEff	Number	Calculated; 40% design maximum efficiency level; Eff_Max x 0.4
	Eff_Min	Number	Minimum efficiency for high discharge 75% quartile
	Eff_MinVar	Number	Calculated; 10% variation minimum efficiency level; Eff_Min - (Eff_Min x 0.1)

Datatable: GPT_WQ1

	Field Name	Data Type	Description
▶ ID		AutoNumber	
🔑	GPT_SampNo	Text	GPT water quality sample number
🔑	GPT_ModNo	Number	Gross Pollutant Trap Modification ID number in GPT_DControl
	Date_S	Date/Time	Sampling Date
	In_SS	Number	Inflow suspended solids, mg/l
	Out_SS	Number	Outflow suspended solids, mg/l
	FlowQ	Number	Flow quartile
	FlowEff	Number	Calculated; Flow efficiency; (Inflow SS - Outflow SS)x100 / Inflow SS
	Action	Text	Action required after comparing with DesMaxEff in GPT_DControl
	Maint_Date	Date/Time	Date on which maintenance work was done

Datatable: DetPond1

	Field Name	Data Type	
▶ ID		AutoNumber	
	DetPond_ID	Text	Unique detention pond identifier
	Lat	Number	Latitude of location in degrees MR50 (central point)
	Long	Number	Longitude of location in degrees MR50 (central point)
	SubCatch	Text	Subcatchment name
	SubCatch_Area	Number	Size of subcatchment area
	DetPond_Width	Number	Width of detention pond in meters
	Notes	Memo	

Wetlands Database

Purpose: *Inventory of wetlands, flora and fauna*

End-user: *Lake and Wetlands Unit, Environment Management Unit*

Background

The wetlands database is an inventory of wetlands identified inside the Putrajaya catchment area including those outside the administrative boundaries Putrajaya. Information on location, size, flora and fauna are included in the database.

Description

Wetland1: The seven wetland areas of Putrajaya have been identified by the wetlands expert in his report. In this datatable, each wetland is given a unique identifier and key information including a name, size and georeference coordinates. The number of subcells identified for wetland plant inventory purposes is also included.

Wetland2: The wetlands have also been subdivided into subcells for the purpose of marking areas where wetland plants are present. There are 22 subcells including the central wetland and the primary lake.

XX_TerPlant: This datatable stores an inventory of the type of terrestrial plants found in each respective wetland and includes a photograph of the item. This datatable can be duplicated and named after each particular wetland cell.

XXX_WetPlant: This is the generic database structure for the wetland plants in each Wetland subcell. This datatable can be duplicated and named after each particular wetland cell.

Fish1: Information from Table 2.7.5 of the report has been transferred into this datatable

Mammal1: Information from Table 2.7.6 of the report has been transferred to this datatable

Birds1: Information from Table 2.7.7 of the report has been transferred to this datatable

Datatable: Wetlands1

	Field Name	Data Type	
▼	Wetland_ID	Text	Wetland identifier
	Wetland_N	Text	Name of wetland
	No_Cell	Text	Number of Subcells
	Area	Number	Area in hectares, approximate
	Lat	Number	Latitude of location in degrees MRSO (central point)
	Long	Number	Longitude of location in degrees MRSO (central point)

Datatable: Wetlands2

	Field Name	Data Type	
▶	Wetland_ID	Text	Wetland identifier
	WetCell_ID	Text	Wetland cell identifier
	Wetland_N	Text	Name of wetland
	Area	Number	Area in hectares, approximate
	Lat	Number	Latitude of location in degrees MRSO (central point)
	Long	Number	Longitude of location in degrees MRSO (central point)

Datatable: XX_TerPlant

This is the generic database structure for the terrestrial plants around each Wetland area. The first 2 letters of the datatable would be the ID initials of the wetland area e.e CW_TerPLant for Central Wetland.

	Field Name	Data Type	
▼	Plant_ID	AutoNumber	
	Plant_Sci_Name	Text	Plant scientific name
	Vern_Name	Text	Vernacular Name
	Plant_Com_Name	Text	Plant common name
	Plant_pix	Hyperlink	Hyperlink to pix gallery


Datatable: XXX_WetPlant


This is the generic database structure for the wetland plants in each Wetland subcell. The first 3 letters of the datatable would be the ID initials of the wetland area e.g. UB1_WetPlant for Upper Bisa subcell 1.


	Field Name	Data Type	
▼	Plant_ID	Number	Unique plant ID number
	Plant_Sci_Name	Text	Scientific name
	Plant_Com_Name	Text	Common name
	Plant_pix	Hyperlink	Hyperlink to picture gallery

Datatable: Mammals1, Birds1, Fish1

Simple datatable structures for inventory of wildlife. A hyperlink field can be added to link the data with pictures.

	Field Name	Data Type	Description
	ID	AutoNumber	
	Mam_Sci_Name	Text	Scientific name
	Mam_Com_Name	Text	Common name English/Malay
	Env_Status	Number	Environmental status;1=protected according to Wildlife Protection ACT, 1972
	Pix	Hyperlink	Photo of wildlife

	Field Name	Data Type	Description
	ID	AutoNumber	
	Bird_Sci_Name	Text	Scientific name
	Bird_Com_Name	Text	Common name English/Malay
	Env_Status	Number	Environmental status;1=protected according to Wildlife Protection ACT, 1972

	Field Name	Data Type	Description
	ID	AutoNumber	
	Fish_Sci_Name	Text	Scientific name
	Fish_Com_Name	Text	Common name English/Malay
	Pix	Hyperlink	Photo

Picture Gallery

Wildlife inventory datatables can be enhanced by photographs. A picture gallery should be created to store all photographs related to the wetland flora and fauna. The hyperlinked fields in XXX_WetPlant, XX_TerPlant, Fish1, Mammal1 and Bird1 would then be associated with this to access the photographs. The photographs should be in JPG or TIF rather than BMP format to conserve space.

Sewerage Database

Purpose: *Inventory of sewage treatment plants in Putrajaya Lake Catchment*

End-user: *Environment Unit*


Background

One potential point source pollutant to the Putrajaya Lake is the discharge of untreated or inadequately treated sewage effluent into the catchment drainage system of the lake. Among the information pertinent to manage sewage in Putrajaya is the location and capacity of the existing and proposed sewage treatment plants. This database houses this information and provides an overall view of the major sewage treatment facilities in the area..

Description

STPlant1: This datatable georeferences the location of all sewage treatment plants in the Putrajaya catchment both inside and outside the Putrajaya administrative boundaries. Records of the capacity of the sewage treatment plant, status of construction and information on the discharge from the plant can be included within STPlant1.

Datatable: **STPlant1**

	Field Name	Data Type	
	ID	AutoNumber	
	STP_ID	Text	STP unique ID
	ServArea_Desc	Memo	Description of area served by STP
	Lat	Number	Latitude of STP location in degrees MR50
	Long	Number	Longitude of STP location in degrees MR50
	Sew_Load	Number	Sewage load or capacity in population equivalent (PE)
	Status	Text	Status of STP; existing, temporary, proposed
	Discharge_notes	Memo	Notes on discharge of effluent

Form: STPlant1

Microsoft Access - [STPlant1]

File Edit View Insert Format Records Tools Window Help

PUTRAJAYA LAKE CATCHMENT

SEWAGE TREATMENT PLANTS

STP_ID: STP

Discharge_rates: Discharge m3 Sg. As. Hban

STP type: Plant

Area served: Phase 1A development

Latitude: 0

Longitude: 0

Sewage load (PS): 100000

Status of STP: Proposed, under construction

Development and Management Plan for Putrajaya Lake

NA/808/1999

Record: 14 of 25

STP unique ID

APPENDIX 7.4

CONCEPTUAL PROPOSAL FOR COMPLETE ICMS

1. INTRODUCTION

The Kawasan Putrajaya, covering an area of about 4,581 hectares, is being developed by the Malaysian Federal government as a new administrative capital. The city is being developed based on a “City in a Garden” concept, with Putrajaya lake forming the focal point. The lake is being formed by the impoundment of Sg. Chuau and has an Catchment area of about 4,500 hectares. The Putrajaya lake is planned to cater to the needs for multi-purpose uses, such as recreation, boating, fishing, water transport etc. Hence a high water quality standard has to be maintained in the lake.

In view of the above, an efficient system has to be develop to monitor and maintain the water quality level of the lake. As many external parameters are contributing to water quality of the lake an integrated system has to be developed to manage the water quality of the lake as well as the ecosystem around the lake and the catchment.

The success of any environment management plan is largely dependent on the timely collection of critical data, proper processing and prompt dissemination to the users and decision makers. In view of the importance attached to the project and the environment, regular updating of the data both spatial and attribute becomes imperative. With technology growing vertically in many segments with overlapping features between features, the web technology has to be leveraged to its best in passing the information to the decision-makers.

Taking into consideration all the factors the complete Integrated Catchment Management System, ICMS, is envisaged to consists of the following:

- ◆ Real time monitoring system
- ◆ Geographical Information System
- ◆ Relational Database Management System
- ◆ Satellite Image Processing System
- ◆ Aerial Photography
- ◆ Web based decision support system

1.1 REAL TIME MONITORING SYSTEM

The technology of Telemetry and computer networking have made it possible to access data in real-time. Real-time hydrological data like rainfall, surface

runoff, temperature, etc make it possible to analyze and determine what influences daily observations will have on the environment.

The system is proposed to support the following functions:

- ◆ Real-time tracking of the hydrological parameters.
- ◆ Reservoir (lake) levels & Level Trending.
- ◆ Monitoring of water quality parameters like pH, turbidity, BOD etc.
- ◆ Warning the users based on user defined threshold.

It is proposed that the real time data collected using the telemetry RTU's be integrated with GIS and RDBMS system.

1.2 GEOGRAPHIC INFORMATION SYSTEM

Geographic Information System (GIS) helps in querying and analyzing the data in a spatial domain. As the definition itself specifies that data plays an important role, the database imparts a major impact on the efficiency of the system. The GIS should be able to support the following functions:

- ◆ Easy mode of data entry, retrieval, analysis and output.
- ◆ Integrate with other systems like Telemetry and RDBMS.
- ◆ Data updating using Aerial photographs.
- ◆ Simulation analysis

The GIS is proposed to act as a GIS web server for web related front-end application.

1.3 RELATIONAL DATABASE MANAGEMENT SYSTEM (RDBMS)

A comprehensive and reliable Database Management System is being proposed as part of the system to support attribute database, storage and management of data and data security. The RDBMS not only stores the attribute database, but also manages the related GIS spatial database.

1.4 SATELLITE IMAGE PROCESSING SYSTEM

To assist in Environmental Impact Assessment studies, landuse/landcover patterns etc, a Satellite Image Processing System is being proposed. This system forms as a data source to GIS in the integrated system.

1.5 AERIAL PHOTOGRAPHY

In order to have up-to-date information of the development surrounding Putrajaya and its catchment, frequent collection of large scale data is proposed, either by using aerial photographs or high resolution satellite images.

1.6 WEB BASED DECISION SUPPORT SYSTEM

To facilitate easy access of selected information by the pertinent regulatory agencies, a web-based information and decision support system is proposed.

2. INTEGRATED CATCHMENT MANAGEMENT SYSTEM

The efficiency of the system depends on the type and amount of data collected and managed in all the components. A close look of data criteria along with the proposed applications and the role of the applications is given below.

2.1 TELEMETRY

For monitoring the water quality parameters like pH, turbidity etc. and quantity parameters such as level of the reservoir (lake), surface flow, setting up of RTUs (Remote Testing Units) at important locations is proposed. Constant monitoring of water quality and water quantity is proposed. A predefined threshold is proposed as a benchmark and an alarm system is triggered once the system moves above or below the threshold values. As an example, the following functions are proposed which may require GIS technology to be embedded.

- ◆ Inform the lake administrator of heavy flow or anomalies
- ◆ Help in locating active pollution zones and identify the possible offenders through GIS
- ◆ Collect water quality parameters
- ◆ Collect hydrological parameters

All data collected from the RTUs and hydrology stations are proposed to be stored in RDBMS.

2.2 GEOGRAPHIC INFORMATION SYSTEM

A GIS client server environment is proposed for all the GIS related functions. Data creation and related activities are proposed to be performed on the server and viewing & query of data is performed on the client systems.

2.3 LAYERS OF DATA

For the purpose of an effective and efficient system, the base data should be relevant, extensive and accurate. Above which all the related information has to be added. A few of the layers which is a must are given below:

- ◆ Geology
- ◆ Topography – slope and aspect

- ◆ Lot Parcels
- ◆ Road Network – different classes
- ◆ Land use/ Land Cover
- ◆ Settlement details at larger scale (with all the existing details)
- ◆ River network
- ◆ Drainage patterns and Water bodies
- ◆ Location of Hydrological stations, Water quality monitoring stations
- ◆ Location of Environmental details
- ◆ Location of RTUs

For each of these layers the attribute data has to be prepared and stored in a RDBMS. Following functions are proposed for the GIS within the ICMS. In the system GIS will be getting data from integrated components also.

- ◆ Query and Analysis of the data
- ◆ Able to access telemetry data

2.4 ENVIRONMENT FUNCTIONS

- ◆ Perform analysis to support Environment Impact Assessment studies
- ◆ Identify the polluting zones and possible offenders (industries)
- ◆ Preparation of environmental zoning mapping
- ◆ Potential zones of sedimentation

2.5 WATER RESOURCES FUNCTIONS

- ◆ Water quality monitoring
- ◆ Watershed management

2.6 PERSPECTIVE VIEWING

- ◆ Landscape management in a 3D perspective
- ◆ Terrain modeling and Fly through

2.7 MAP UPDATING

- ◆ Update the data using high resolution data

2.8 ENVIRONMENTAL ZONE MAPPING

A comprehensive and integrated map is proposed to have up to date zoning map, categorized based on the environmental, geological, landuse/landcover, hydrological parameters.

2.9 SATELLITE IMAGE PROCESSING

This system is proposed to function as a sub-system to GIS and is proposed to perform the following functions

- ◆ Landuse/landcover maps
- ◆ Reservoir siltation analysis
- ◆ Change detection studies
- ◆ Updating of details at smaller scale

2.10 MAP UPDATING

To regularly update the details of the Putrajaya area, procurement of aerial photographs or high-resolution satellite images is recommended. A scale of 1:10,000 or larger is recommended.