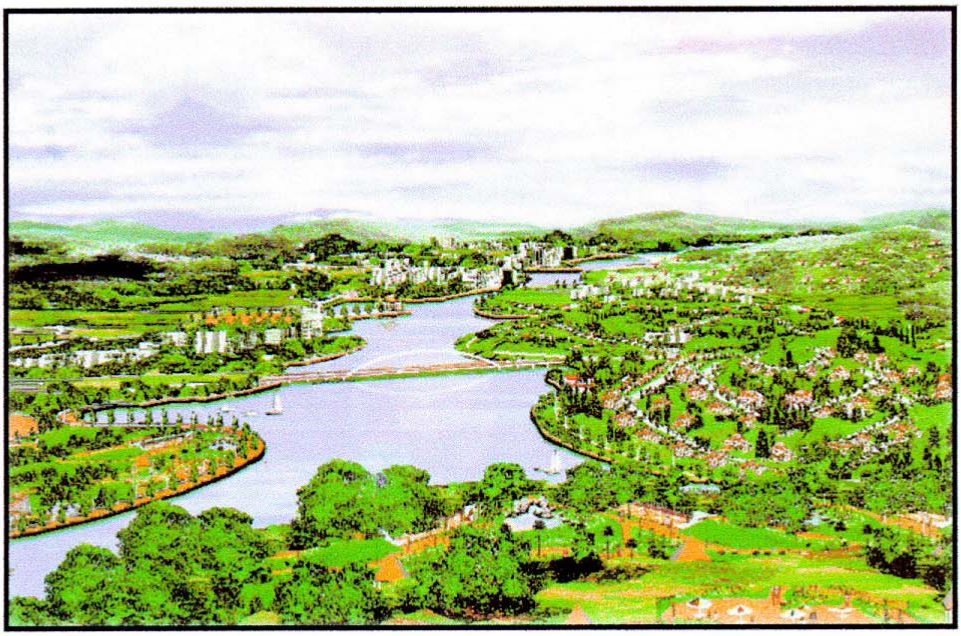
PERBADANAN PUTRAJAYA

CATCHMENT DEVELOPMENT AND MANAGEMENT PLAN FOR PUTRAJAYA LAKE

VOLUME 1 : MAIN REPORT



Submitted by :

Institut Penyelidikan Hidraulik Kebangsaan Malaysia
(National Hydraulic Research Institute of Malaysia)
Kementerian Pertanian, Blok A,
JPS Malaysia Cawangan Jalan Ampang,
KM 7, Jalan Ampang, 68000 Ampang.

In Association with :

KTA Tenaga sdn bhd
CONSULTING ENGINEERS • JURUTERA PERUNDING
Company No: 239199-V
Level 5, Uptown 2, Damansara Uptown,
No. 2, Jalan SS 21/37, Damansara Utama,
47400 Petaling Jaya. Selangor.
TEL: 03-7666 3333 FAX: 03-7666 3322
E-mail: ktaten@po.jaring.my

MHA Enviro. Consult. Sdn Bhd
No. 25, 2nd Floor,
Jalan Tengku Ampuan Zabedah F,
9/F Section 9,
40100 Shah Alam, Selangor.

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VOLUME 1 : MAIN REPORT

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LIST OF ABBREVIATIONS

AAR	Average Annual Rainfall
AE	Actual Evaporation
AEP	Annual Exceedance Probability
AD	Advection – Dispersion
ARI	Average Recurrence Interval
BMP	Best Management Practices
BOD	Biological Oxygen Demand
CALSITE	Calibrated Simulation of Transported Erosion
COD	Chemical Oxygen Demand
Cr	Chromium
CW	Central Weir
DCIA	Directly Connected Impervious Areas
DID	Department of Irrigation and Drainage
DO	Dissolved Oxygen
DOE	Department of Environment
ED	Extended Detention
EMP	Environmental Management Plan
EPF	Employee Provident Fund
EQA	Environmental Quality Act
ERL	Express Rail Link
ESCP	Erosion and Sediment Control Plan
ESS	Electronic Submission Standards
GIO	Geographical Information Officer
GIS	Geographical Information System
GPT	Gross Pollutant Trap
GSM	Geological Survey of Malaysia
GUI	Graphical User Interface
HAZOP	Hazards and Operability
HD	Hydrodynamics
Hg	Mercury
ICMS	Integrated Catchment Management System
IDF	Intensity – Duration – Frequency
IMP	Information Management Plan
INRWQSM	Interim National Water Quality Standards for Malaysia
IOI	Integrated Oxygen Industries Sdn Bhd

IPM	Integrated Pest Management
ITU	Information Technology Unit
IU	Information Unit
IWK	Indah Water Consortium
JAS	*Jabatan Alam Sekitar*
JKR	*Jabatan Kerja Raya*
JPBD	*Jabatan Perancangan Bandar dan Desa*
JPN	*Jawatankuasa Perancangan Negeri*
JPP	*Jabatan Perkhidmatan Pembentungan*
JPS	*Jabatan Pengairan dan Saliran*
KLIA	Kuala Lumpur International Airport
KPP	*Kawasan Perbadanan Putrajaya*
LE	Lower East Wetland
LGA	Local Government Act
MAM	Mean Annual Minimum
MAR	Mean Annual Rainfall
MARDI	Malaysian Agricultural Research and Development Institute
MDC	Multi-media Development Corporation
MDS	*Majlis Daerah Sepang*
MMKN	*Majlis Mesyuarat Kerajaan Negeri*
Mn	Manganese
MPN	*Majlis Pembangunan Negeri*
MPSJ	*Majlis Perbandaran Subang Jaya*
MS	Malaysian Standard
MSC	Multimedia Super Corridor
N	Nitrogen
NALIS	National Land Information System
NLC	National Land Council
NH_3	Ammonia
NPS	Non-point Source
NWRS	National Water Resources Study
O & G	Oil and Grease
OP	Dissolved Phosphorus
OSHA	Occupational Safety and Health Act
P	Phosphorus
Pb	Lead

PE	Population Equivalent
PLCMC	Putrajaya lake Catchment Management Committee
Phosphorus Dis.	Dissolved Phosphorus
Phosphorus Par.	Particulate Phosphorus
PP	Particulate Phosphorus
PPA	Perbadanan Putrajaya Act
PTD	*Pejabat Tanah dan Daerah*
PTG	*Pejabat Tanah dan Galian*
R & D	Research and Development
SAMM	*Skim Akreditasi Makmal Malaysia*
SCC	Stakeholders' Consultative Committee
SDBA	Street, Drainage & Building Act
SOCSO	Social Security Organisation
SPS	Serdang Power Station
STP	Sewage Treatment Plant
SWMA	Selangor Waters Management Authority
SWMAE	Selangor Waters Management Authority Enactment
TCPA	Town and Country Planning Act
TD	Temporary Dam
TN	Total Nitrogen
TNB	Tenaga Nasional Berhad
TOR	Terms of Reference
TP	Total Phosphorus
UB	Upper Bisa Wetlands
UDDS	Urban Drainage Design Standard
UDG	Urban Design Guidelines
UE	Upper East Wetlands
UN	Upper North Wetlands
UW	Upper West Wetlands
UNITEN	Universiti Tenaga Malaysia
UPEN	*Unit Perancang Ekonomi Negeri*
UPM	Universiti Putra Malaysia
URS	User Request Study
USLE	Universal Soil Loss Equation
WPCP	Water Pollution Control Pond
WQ	Water Quality
WQCMS	Water Quality Catchment Management System
Zn	Zinc

*R*ingkasan *E*ksekutif

RINGKASAN EKSEKUTIF

1.0 OBJEKTIF KAJIAN

1.1 Kerajaan Pusat sedang giat membangunkan Kawasan Putrajaya untuk menjadikannya sebuah " Bandar di dalam taman" di mana Tasik Putrajaya, seluas 552 hektar, adalah tumpuan utama kawasan itu. Tasik Putrajaya ini akan digunakan untuk pelbagai jenis kegunaan dan ia seharusnya dikekalkan di dalam keadaan aslinya dan mempunyai kualiti air yang tinggi pada setiap masa.

1.2 Kawasan Putrajaya merangkumi 70% daripada kawasan tadahan Tasik Putrajaya. Kerja–kerja pembangunan yang dijalankan di dalam Kawasan Putrajaya akan dikawal ketat oleh Pelan Induk Putrajaya dan peraturan–peraturan yang telah ditetapkan oleh Perbadanan Putrajaya. Akan tetapi, pihak kerajaan Pusat bimbang akan pembangunan tidak terkawal yang dijalankan di dalam 30% kawasan, di hulu kawasan tadahan tasik yang terletak diluar kawasan Putrajaya.

1.3 Untuk mencapai dan memelihara tahap kualiti air yang tinggi yang telah ditetapkan untuk Tasik Putrajaya, sebuah Pelan Pembangunan dan Pengurusan Kawasan Tadahan harus disediakan untuk kawasan Tadahan Tasik Putrajaya. Pelan ini harus menerang dan mendefinisikan pelan–pelan induk kegunaan tanah, sistem saliran dan pembetungan untuk kawasan–kawasan diluar Putrajaya untuk digabungkan bersama di dalam pelan-pelan induk yang berkenaan untuk Kawasan Putrajaya. Pelan Pembangunan dan Pengurusan Kawasan Tadahan ini juga dikehendaki menerangkan butir-butir terperinci untuk mewujudkan undang-undang kawalan yang selaras untuk kawasan-kawasan diluar Putrajaya.

2.0 ISU – ISU DAN CADANGAN PENGURUSAN KAWASAN TADAHAN

2.1 PENGURUSAN KUALITI AIR TASIK

2.1.1 Buat masa sekarang, kualiti air Tasik Putrajaya memenuhi semua syarat yang ditetapkan oleh Perbadanan Putrajaya kecuali bagi 2 parameter iaitu " E-Coli" dan "Phosphorus".

Cara yang paling efektif untuk mencapai tahap kualiti air yang dikehendaki adalah dengan mengurangkan penghasilan bahan pencemaran di punca-punca pencemaran. Tambahan pula, masalah hakisan dan kelodakan semasa fasa-fasa pembersihan kawasan, kerjatanah dan kerja-kerja pembinaan telah dikenalpasti akan menimbulkan ancaman terhadap kualiti air Tasik.

2.1.2 **Cadangan**

- *Untuk pengendalian pencemaran pada puncanya, sistem saliran hendaklah berasaskan penampan tebing tasik berlanskap dengan tumbuhan (vegetated landscape riparian buffer), sistem saliran berserambi (drainage corridors) dan sistem kolam takungan (mini wetland pond) untuk meninggikan kualiti air.*
- *Untuk mengelakkan kemasukan sampah, GPTs hendaklah dipasangkan di hujung setiap parit atau longkang konkrit yang mengalir masuk ke serambi saliran yang berlanskap dengan tumbuhan (vegetated landscape drainage corridors).*
- *Untuk memastikan keberkesanan kawalan hakisan dan kelodakan semasa kerjatanah dilakukan, adalah dicadangkan satu "Peraturan Kecil Kawalan Hakisan dan Kelodakan" diwartakan oleh Perbadanan dan Majlis Daerah Sepang. Cadangan bagi peraturan baru itu haruslah disokong dengan sebuah buku panduan untuk "Piawaian untuk Kawalan Hakisan dan Kelodakan".*

2.2 PENGURUSAN PUNCA PENCEMARAN

2.2.1 Air kumbahan yang dihasilkan oleh MARDI, UPM dan IOI telah dikenalpasti sebagai punca-punca utama pencemaran. Masalah in telah dikawal di dalam *Pelan Induk Pembetungan*.

2.2.2 Kemalangan yang mungkin akan disebabkan oleh lori tangki minyak yang menggunakan jalan yang melalui kawasan "wetlands" berpotensi menjadi salah satu daripada punca pencemaran utama. Oleh itu, pihak berkuasa yang berkenaan (JKR/PJH) harus memastikan bahawa ERP dan tatacara disediakan dan dilaksanakan bagi membendung pencemaran akibat daripada kemalangan seperti yang disebutkan.

2.2.3 Pencemaran bukan berpunca (*non-point)* daripada air larian jalan akan dikawal melalui perlaksanaan sistem saliran yang berasaskan sistem saliran berserambi dan bertumbuhan. Pencemaran bukan berpunca yang diakibatkan oleh pengunaan baja dan racun serangga di MARDI, UPM, IOI dan Cyberjaya harus dikawal menerusi kawalan undang-undang dengan menggunakan panduan 'BMP' yang telah disediakan untuk penggunaan baja dan racun serangga.

2.3 PENGURUSAN KUANTITI AIR

2.3.1 Adalah mustahak bahawa semua air hujan di dalam kawasan tadahan ini disalirkan ke dalam sistem Tasik Putrajaya . Selain daripada itu, kawalan kuantiti air untuk kegunaan pengairan atau lain-lain kegunaan juga harus disediakan.

2.3.2 **Cadangan**

- *Sebarang penyimpangan atau perubahan ke atas sistem saliran semulajadi di dalam kawasan tadahan tidak dibenarkan*
- *Kadaralir Pampasan (compensation flow) bersamaan dengan 10% daripada purata tahunan kadaralir adalah dibenarkan semasa pengisian empangan utama*
- *Enam (6) lubang perigi bawahtanah akan digali dihilir empangan utama untuk membekalkan 0.013 m^3/s (10,000 g/jam) air bawah tanah untuk memenuhi segala keperluan air.*
- *Kajian berasingan Pelan Induk Pengairan yang mengandungi kajian kesan menadah air hujan (rainwater harvesting) di dalam kawasan tadahan ke atas kuantiti air di dalam Tasik harus dijalankan*

2.4 PELAN KEGUNAAN TANAH

2.4.1 Pembahagian tanah utama di luar Kawasan Putrajaya terdiri daripada lapan (8) tuan tanah iaitu UPM, MARDI, IOI, TNB, West Country, UNITEN, Cyberjaya dan Kawasan Rezab Melayu Sg. Merab. Sebuah Pelan Kegunaan Tanah telah disediakan untuk memastikan setiap pembangunan di kawasan-kawasan ini selaras dengan objektif untuk kawasan tadahan.

2.4.2 Pelan ini akan digabungkan dengan Pelan Tempatan Kawasan MSC yang sedang disediakan oleh JPBD.

2.5 PELAN SALIRAN

Pelan Induk Saliran ini mengandungi

- *Cadangan Pelan dan Garis Panduan Rekabentuk Saliran yang berasaskan konsep saliran berserambi dengan tumbuhan (vegetated drainage corridors)*
- *Cadangan-cadangan khusus untuk meningkatkan tahap sistem saliran di kawasan UPM, MARDI, IOI, West Country dan Cyberjaya.*

2.6 PELAN PEMBETUNGAN

Pelan Induk Pembetungan mengandungi

- Cadangan Pelan dan Garis Panduan Rekabentuk Pembetungan
- Cadangan-cadangan khusus untuk pengurusan effluen air kumbahan yang dihasilkan oleh MARDI, UPM, IOI dan Cyberjaya.

2.7 KAWALAN DAN PERANCANGAN KEGUNAAN TANAH

2.7.1 Kawalan dan Perancangan kegunaan tanah untuk kawasan tadahan merupakan mekanisma utama untuk perlindungan kualiti air di dalam tasik. Akan tetapi, mekanisma dan struktur untuk kawalan dan pengurusan di Majlis Daerah Sepang (MDS) dan Majlis Perbandaran Subang Jaya (MPSJ) tidak begitu tersusun jika dibandingkan dengan kawasan Putrajaya.

2.7.2 **Cadangan**

(a) *Menyediakan dan mewartakan pelan tempatan untuk kawasan di luar Putrajaya. JPBD akan melaksanakan cadangan ini sebagai sebahagian daripada pelan tempatan untuk kawasan MSC.*

(b) *Melaksanakan keperluan pemprosesan untuk pengemukaan dan kelulusan pelan seperti mana yang dijalankan oleh Perbadanan, untuk semua cadangan projek pembangunan di dalam kawasan tadahan di bawah pentadbiran MDS.*

(c) *Menugaskan seorang Juruperancang dan seorang Pembantu Teknik tambahan ke MDS untuk membantu menjalankan kerja-kerja tambahan yang timbul akibat daripada perlaksanaan keperluan untuk pemprosesan*

pelan terperinci yang telah disebutkan di dalam (b) di atas.

2.8 KAWALAN DAN PENGURUSAN SALIRAN

2.8.1 Pendekatan bersepadu untuk isu ini tidak dapat diambil kerana tanggungjawab terhadap saliran terletak kepada JPS, Kerajaan Tempatan dan agensi-agensi seperti JKR dan pemaju-pemaju tanah.

2.8.2 **Cadangan**

(a) Semua projek pembangunan, termasuk projek utiliti dan pengangkutan harus mematuhi konsep dan garis panduan rekabentuk saliran yang disediakan untuk Kawasan Tadahan Tasik Putrajaya

(b) Menugaskan seorang Jurutera Awam dan seorang Pembantu Teknik tambahan ke MDS untuk memberi perhatian khusus kepada saliran dan kerjatanah untuk pembangunan di dalam Kawasan Tadahan Tasik Putrajaya.

2.9 KAWALAN PENGURUSAN AND PENCEMARAN ALAM SEKITAR

2.9.1 Pada masa sekarang, tidak terdapat penubuhan organisasi di dalam MDS dan MPSJ untuk menguruskan isu-isu alam sekitar seperti kawalan pencemaran air, pengurusan air larian dan lain-lain isu yang boleh menjejaskan kualiti air tasik.

2.9.2 **Cadangan**

(a) Melaksanakan keperluan yang tercatat di dalam Buku Panduan Pengurusan Alam Sekitar untuk Putrajaya untuk semua projek pembangunan di dalam Kawasan Tadahan Tasik Putrajaya.

(b) Untuk memastikan pengurusan bersepadu di kawasan tebing tasik Putrajaya, adalah dicadangkan zon hijau penampan selebar 20m di tepi tasik di dalam kawasan Cyberjaya diuruskan oleh Perbadanan Putrajaya.

(c) Mewujudkan Unit Alam Sekitar di dalam MDS dan menugaskan seorang Pegawai Alam Sekitar dan seorang Pembantu Teknik untuk menguruskan unit tersebut. Unit ini bertanggungjawab untuk melaksanakan semua peraturan dan tanggungjawab Unit Alam Sekitar

sepertimana yang dicatatkan di dalam Buku Panduan yang tersebut di (a) di atas, untuk projek-projek pembangunan di dalam kawasan pentadbiran MDS.

2.10 PENYELARASAN ANTARA AGENSI-AGENSI PENGUATKUASA

2.10.1 Penyelarasan di antara Perbadanan, kedua-dua pihak berkuasa tempatan dan agensi-agensi dan jabatan-jabatan kerajaan adalah diperlukan untuk menguruskan pembangunan dan aktiviti-aktiviti manusia di dalam kawasan tadahan.

2.10.2 Kerajaan Pusat telah mengenalpasti kenyataan ini dan telah menubuhkan Jawatankuasa Pengurusan Tasik Putrajaya (*Putrajaya Lake Catchment Committee, PLMC)* untuk melancarkan proses diatas. Walau bagaimanapun, PLMC hanya bertindak sebagai Jawatankuasa Pentadbir dan tidak memegang sebarang kuasa undang-undang.

2.10.3 **Cadangan**

(a) Menubuhkan sebuah Jawatankuasa yang sah di bawah enakmen Lembaga Urusan Air Selangor (LUAS)

(b) Ahli-ahli Jawatankuasa yang dicadangkan adalah seperti berikut: (tidak melebihi 12 ahli)

Pengerusi: Setiausaha Kerajaan Negeri/ Wakil

Ahli:

1) Lembaga Urusan Air Selangor
2) Jabatan Pengairan dan Saliran
3) Jabatan Alam Sekitar
4) Jabatan Perancangan Bandar dan Desa
5) Perbadanan Putrajaya
6) Majlis Perbandaran Subang Jaya
7) Majlis Daerah Sepang
8) Jabatan Kerja Raya
9) Jabatan Perkhidmatan Pembetungan
10) Wakil Jawatankuasa Perundingan Tuan Tanah

Sekretariat: LUAS/ Unit "Wetlands" dan Tasik Perbadanan Putrajaya

(c) Fungsi Jawatankuasa adalah terhad kepada pengurusan bersepadu kawasan tadahan Tasik Putrajaya, *untuk kawasan di luar Putrajaya.*

(d) Jawatankuasa ini hendaklah dirasmikan oleh LUAS pada akhirnya. Pada tahap interim, Jawatankuasa Pengurusan Tasik Putrajaya (PLMC) akan terus berfungsi.

(e) Perbadanan Putrajaya akan diamanahkan untuk menjalankan fungsi-fungsi pengawasan.

(f) Sebuah Jawatankuasa Perundingan Tuan Tanah dicadangkan untuk ditubuhkan. Jawatankuasa ini akan beranggotakan wakil-wakil dari tuan-tuan tanah utama di kawasan tadahan dan dari Pertubuhan-pertubuhan Penghuni.

2.11 PENGAWASAN DAN PEMERIKSAAN

Untuk membantu pengawasan dan pemeriksaan ke atas keberkesanan perlaksanaan Pelan ini, adalah dicadangkan supaya:

- Rangkaian pengawasan hidrologi disediakan
- Rangkaian pengawasan kualiti air disediakan
- ICMS tahap rendah dilaksanakan

2.12 SISTEM PENGURUSAN KAWASAN TADAHAN

Sebuah sistem pengurusan kawasan tadahan yang terdiri daripada 10 unsur, telah dicadangkan untuk digunakan oleh Jawatankuasa Pengurusan Kawasan Tadahan Tasik untuk membantu perlaksanaan dan pengawasan Pelan ini.

1. Polisi Pengurusan Kawasan Tadahan
2. Isu Pengurusan Kawasan Tadahan
3. Peraturan dan Lain-lain Keperluan
4. Objektif dan Matlamat Pengurusan Kawasan Tadahan
5. Program Pengurusan Kawasan Tadahan
6. Struktur Institusi Pengurusan Kawasan Tadahan
7. Penyertaan Masyarakat/ Tuan Tanah di dalam Kawasan Tadahan
8. Kesedaran dan Keperluan Latihan

9. Persediaan Kecemasan dan Reaksi
10. Pengawasan dan Pemeriksaan

3.0 JADUAL PERLAKSANAAN, TAKSIRAN PERBELANJAAN DAN SUMBER WANG

3.1 JADUAL PERLAKSANAAN DAN TAKSIRAN PERBELANJAAN

3.1.1 Jadual E1 menunjukkan jadual perlaksanaan dan taksiran perbelanjaan untuk program-program yang telah dicadangkan oleh pakar-pakar berkenaan untuk tempoh perlaksanaan selama 3 tahun.

3.1.2 Jadual E1 juga menunjukkan anggaran jumlah kos 3-tahun untuk program-program yang dicadangkan iaitu sebanyak *RM26.6 juta.* Ia mengandungi perbelanjaan modal sebanyak *RM 20.3 juta* dan perbelanjaan pengurusan dan pemeliharaan sebanyak *RM 6.3 juta*.

3.1.3 Program-program berikut telah dicadangkan untuk dilaksanakan dalam tahun pertama selepas kelulusan Pelan Pengurusan Kawasan Tadahan Tasik:

- Rangkaian Pengawasan Kualiti Air
- Rangkaian Pengawasan hidrologi
- Pengawasan efluen air kumbahan
- Memperbaiki kualiti air kumbahan di UPM
- Pemasangan ICMS
- Memperkukuhkan Institusi (menambahkan kakitangan MDS)

3.2 SUMBER WANG

3.2.1 Tiga (3) punca utama sumber wang untuk menjayakan perlaksanaan cadangan Jururunding adalah

- Kerajaan Pusat
- Kerajaan Negeri Selangor
- Tuan-tuan Tanah

PELAN PEMBANGUNAN DAN PENGURUSAN KAWASAN TADAHAN TASIK PUTRAJAYA

	MODAL (RM)					KOS PENGURUSAN & PEMELIHARAAN (RM)					HURAIAN
PROGRAM	**Tahun 1**	**Tahun 2**	**Tahun 3**	**Tidak berjadual**	**Jumlah**	**Tahun 1**	**Tahun 2**	**Tahun 3**	**Tidak Berjadual**	**Jumlah**	
1. Rangkaian Pengawasan Kualiti Air	335,000	425,000	335,000		**1,095,000**	725,000	1,815,000	2,446,400		**4,986,400**	Kos mengambil
											contoh juga termasuk
2. Pembangunan Perigi-perigi Air Bawah				144,000	**144,000**				16,433	**16,433**	Akan dilaksanakan
Tanah											apabila diperlukan
3. Rangkaian Pengawasan Hidrologi	881,000	0	0	881,000	**881,000**	69,000	69,000	69,000		**207,000**	
4. Memperbaiki Sistem Saliran											Akan dilaksanakan
(a) MARDI				8,942,400	8,942,400				56,000	56,000	sebagai program
(b) UPM				7,776,000	7,776,000				60,000	60,000	pembangunan
(c) IOI				72,000	72,000				14,400	14,400	tuan-tuan tanah
(d) West Country				31,500	31,500				6,300	6,300	
(e) Cyberjaya				81,000	81,000				16,200	16,200	
					16,902,900					**152,900**	
5. Memperbaiki/Mengawas Air Kumbahan											
(a) UPM	854,000				854,000	55,800	55,800	55,800		167,400	
(b) MARDI	240,000				240,000	37,200	37,200	37,200		111,600	
(c) IOI	0				0	9,300	9,300	9,300		27,900	
(d) Cyberjaya	0				0	37,200	37,200	37,200		111,600	
					1,094,000	139,500	139,500	139,500		**418,500**	
6. Memasang dan Memperbaiki ICMS	20,500	200,000			**220,500**						
7. Memperkukuhkan Institusi (menambah						167,000	167,000	167,000		**501,000**	
kakitangan)											
JUMLAH KOS	**2,330,500**	**625,000**	**335,000**	**17,927,900**	**20,337,400**	**1,100,500**	**2,190,500**	**2,821,900**	**169,333**	**6,282,233**	

3.2.2 Jadual E2 menunjukkan punca-punca sumber wang untuk program-program yang dicadangkan.

3.2.3 Adalah dijangkakan bahawa modal tidak akan dapat diperolehi kembali. Oleh itu, pihak-pihak kerajaan tempatan, negeri dan pusat harus menimbangkan perlaksanaan cara untuk memperoleh kembali kos untuk membiayai program pengawasan di dalam kawasan tadahan tasik. Berikut adalah dua (2) pilihan polisi yang mungkin dapat memperoleh kembali kos:

- mengamalkan dan melaksanakan polisi " pencemar akan menanggung"
- mengamalkan dan melaksanakan " penerima yang bermanfaat secara langsung akan menanggung"

JADUAL E2 PUNCA-PUNCA SUMBER WANG

SUMBER WANG	PROGRAM	MODAL (RM)	KOS PENGURUSAN & PEMELIHARAAN (RM)	HURAIAN
Perbadanan Putrajaya	1. Rangakaian Pengawasan Kualiti Air	1,095,000	4,986,400	Dilaksanakan dalam Tahun 1 di bawah tempoh 3 tahun
	2. Pembangunan Perigi-perigi Air Bawah Tanah	144,000	16,433	Dilaksanakan apabila diperlukan
	3. Rangkaian Pengawasan Hidrologi	881,000	207,000	Dilaksanakan dalam Tahun 1
	4. Pengawasan Efluen Air Kumbahan		418,500	Dilaksanakan dalam Tahun 1 di bawah tempoh 3 tahun
	5. Pemasangan ICMS	20,500		Dilaksanakan dalam Tahun 1 di bawah tempoh percubaan selama 6 bulan
	6. Memperbaiki ICMS	200,000		Keputusan akan ditentukan oleh tempoh percubaan
ANGGARAN JUMLAH KOS DITANGGUNG OLEH PERBADANAN PUTRAJAYA		**2,340,500**	**5,628,333**	
Kerajaan Pusat	1. Kos Mamperbaiki Sistem Air Kumbahan	1,094,000		Kerja-kerja memperbaiki sistem air kumbahan di UPM dan MARDI akan dilaksanakan dalam Tahun 1 (bergantung kepada rundingan di antara UPM & MARDI)
	2. Memperkuatkan Institusi		167,000	1. Kos Pengurusan dan Pemeliharaan Tahunan 2. Dilaksanakan dalam Tahun 1 3. Bergantung kepada rundingan bersama pihak Kerajaan Negeri Selangor
	3. Kos Pemeliharaan Sistem Saliran		152,900	Kerajaan Pusat akan membiayai program pemeliharaan di kawasan luar Putrajaya
ANGGARAN JUMLAH KOS DITANGGUNG OLEH KERAJAAN PUSAT		**1,094,000**	**319,900**	
Kerajaan Negeri Selangor	Memperkuatkan Institusi		167,000	1. Kos Pengurusan dan Pemeliharaan Tahunan 2. Dilaksanakan dalam Tahun 1 3. Bergantung kepada rundingan bersama pihak Kerajaan Pusat
ANGGARAN JUMLAH KOS DITANGGUNG OLEH KERAJAAN NEGERI SELANGOR			**167,000**	
MARDI	1. Kos Memperbaiki Sistem Saliran	8,942,400		Akan dilaksanakan sebagai program pembangunan MARDI
	2. Kos Memperbaiki Sistem Air Kumbahan	240,000		Bergantung kepada rundingan bersama pihak Kerajaan Pusat (dilaksanakan dalam Tahun 1)
ANGGARAN JUMLAH KOS DITANGGUNG OLEH MARDI		**9,182,400**		
IOI	Kos Memperbaiki Sistem Saliran	**72,000**		
ANGGARAN JUMLAH KOS DITANGGUNG OLEH IOI		**72,000**		
West Country	Kos Memperbaiki Sistem Saliran	**31,500**		Akan dilaksanakan sebagai program pembangunan tuan-tuan tanah
ANGGARAN JUMLAH KOS DITANGGUNG OLEH WEST COUNTRY		**31,500**		
Cyberjaya	Kos Memperbaiki Sistem Saliran	**81,000**		
ANGGARAN JUMLAH KOS DITANGGUNG OLEH CYBERJAYA		**81,000**		
SKVE	Kos Memperbaiki Sistem Saliran**			
ANGGARAN JUMLAH KOS DITANGGUNG OLEH PROJEK SKVE		**		Memperbaiki sistem saliran di UPM dan MARDI di kawasan-kawasan yang terlibat dengan projek ** Kos tidak dapat dianggarkan
ERL	Kos Memperbaiki Sistem Saliran**			
ANGGARAN JUMLAH KOS DITANGGUNG OLEH PROJEK ERL		**		
UPM	1. Kos Memperbaiki Sistem Saliran	7,776,000		Akan dilaksanakan sebagai program pembangunan UPM
	2. Kos Memperbaiki Sistem Air Kumbahan	854,000		Bergantung kepada rundingan bersama pihak Kerajaan Pusat (dilaksanakan dalam Tahun 1)
ANGGARAN JUMLAH KOS DITANGGUNG OLEH UPM		**8,630,000**		

*E*xecutive *S*ummary

EXECUTIVE SUMMARY

1.0 OBJECTIVE OF STUDY

1.1 Putrajaya is being developed by the Federal Government into a "City in a Garden" with the 552 hectares Putrajaya Lake as its focal point. The Lake is required to cater for multi-functional uses and has to be always in pristine condition, with a high water quality.

1.2 Within Putrajaya, which occupies about 70% of the Lake catchment area, developments are controlled by the Putrajaya masterplan and stringent regulatory controls by the Perbadanan Putrajaya. However, the Federal Government is concerned about the uncontrolled developments in the 30% upstream areas of the catchment, outside Putrajaya.

1.3 In order to achieve and maintain the high water quality objective set for Putrajaya Lake a Comprehensive Catchment Development and Management Plan for the Putrajaya Lake Catchment has to be prepared. The Plan has to define the land-use, drainage and sewerage masterplans for the areas outside Putrajaya to integrate them to the pertinent masterplans for Putrajaya. It has to also define the details for the integrated regulatory control for the areas outside Putrajaya.

2.0 CATCHMENT MANAGEMENT ISSUES & RECOMMENDATIONS

2.1 WATER QUALITY MANAGEMENT

2.1.1 The current water quality in the Lake are within the limiting values of all the parameter values in the Putrajaya Lake Water Quality, except for E-Coli and Phosphorus. It is recognised that the most effective way to attain the desired water quality objective is to *minimise the generation of pollutants at their source*. Also, it is recognised that erosion and transport of sediments during the land clearing, earthworks and construction phase pose a very serious threat to the Lake water quality.

2.1.2 **Recommendations:**

- *To manage pollutants at source the drainage system should be based on vegetated landscape riparian buffers, drainage corridors and mini-wetlands water quality enhancement ponds.*
- *To prevent the entry of rubbish Gross pollutant/sediment trap (GPT) structures are to be installed at the ends of all concrete drains flowing into the vegetated landscape drainage corridors.*
- *To ensure effective control of erosion and sediment during earthworks it is recommended that a new "Erosion and Sediment Control By-Law" be enacted by the Perbadanan and the Majlis Daerah Sepang. The recommended By-Law should be supported by a new "Standards for Erosion and Sediment Control" Manual.*

2.2 POLLUTANT SOURCES MANAGEMENT

2.2.1 The sewage effluent discharge from MARDI, UPM and IOI have been identified to be the major point pollutant sources. *They are controlled in the sewerage masterplan.*

2.2.2 Accidents associated with the oil tankers moving along the road passing through the wetlands can be a major point pollutant source. Thus, *the pertinent authorities (JKR, Perbadanan) has to ensure that Emergency Response Plans and Procedures are prepared and implemented to handle such potential emergencies.*

2.2.3 Non-point pollutant sources from road runoffs are to be controlled through the *implementation of the drainage system based on vegetated drainage corridor.* Those from fertiliser and pesticide inputs from MARDI, UPM, IOI and Cyberjaya are to be controlled by *regulatory measures using the prepared BMP guidelines on the use of fertilisers and pesticides.*

2.3 WATER QUANTITY MANAGEMENT

2.3.1 It is important that all possible runoff arising from the Lake catchment should enter into the Lake system. Also, there should be proper control over the amount of water drawn for irrigation or other purposes.

2.3.2 **Recommendations**

- *No diversion or alteration of the natural drainage lines in the catchment is to be allowed.*
- *Compensation flow equal to 10% of the Annual Average Flow may be allowed during the in-filling of the main dam.*
- *A well field of 6 groundwater wells can be developed, downstream of the main dam, to supply 0.013 m^3/s (10,000 g/hr) of groundwater to meet any water demand.*
- *A separate irrigation masterplan study has to be carried out, which shall include a study on the impact of the proposed rainwater harvesting within the catchment on the water quantity in the Lake.*

2.4 LAND-USE PLANNING

2.4.1 The major land parcels in the catchment areas outside Putrajaya are UPM, MARDI, IOI, TNB, West Country, UNITEN, Cyberjaya and the Sg. Merab Malay Reserve. To ensure that the development in the above areas are in line with the objectives for the catchment a land-use masterplan has been prepared.

2.4.2 *The plan will be incorporated in the MSC areas Local Plan that is currently being prepared by the JPBD.*

2.5 DRAINAGE PLANNING

2.5.1 The Drainage Masterplan comprises of:

- *Recommended Drainage Planning and Design Guidelines based on the vegetated drainage corridor concepts.*
- *Specific recommendations for upgrading the drainage systems in UPM, MARDI, IOI, West Country and Cyberjaya.*

2.6 SEWERAGE PLANNING

2.6.1 The sewerage masterplan comprises of:

- *Recommended Sewerage Planning and Design Guidelines*
- *Specific recommendations for the management of the sewage effluent discharge from MARDI, UPM, IOI and Cyberjaya. .*

2.7 PLANNING AND LAND-USE CONTROL

2.7.1 Planning and land use control of areas within the catchment represents one of the most important mechanisms for the protection of the water quality in the Lake. The mechanism and set-up for control and management of planning in the Majlis Daerah Sepang (MDS) and Majlis Perbandaran Subang Jaya (MPSJ) is not as well organised as in Putrajaya.

2.7.2 **Recommendations**:

(a) To develop and gazette local plans for the land parcels outside Putrajaya. This will be carried out by the JPBD as part of the local plan for the MSC Area.

(b) To implement similar planning submission and approval process requirements as those in the Perbadanan, for all proposed development projects in the catchment areas of the Majlis Daerah Sepang (MDS).

(c) To assign an additional Planner and Technical Assistant to the MDS to cope with the increase workload due to the additional work arising from the implementation of the detailed planning submission requirements above.

2.8 DRAINAGE MANAGEMENT AND CONTROL

2.8.1 There is no integrated approach to this issue since the responsibilities for drainage lies with the JPS, the local authorities and other agencies such as the JKR and other developers.

2.8.2 **Recommendations**:

(a) *To require all development projects, including utilities and transportation projects to comply with the recommended drainage concept and design guidelines for the Putrajaya Lake catchment.*

(b) *To assign an additional Civil Engineer and Technical Assistant to the MDS so that they can give special attention to drainage and earthworks for developments in the Putrajaya Lake catchment areas.*

2.9 ENVIRONMENTAL MANAGEMENT AND POLLUTION CONTROL

2.9.1 There is presently no organisational set-up in the MDS and MPSJ to effectively manage environmental issues, such as control of water pollution, runoff management and others that affect the Lake water quality.

2.9.2 **Recommendations**:

(a) To implement the requirements of the Putrajaya Environmental Management Guide for all development projects in the Putrajaya Lake catchment.

(b) To ensure integrated management of the Lake waterfront environment it is recommended that the 20-metre green zone buffer along the Lake in the Cyberjaya area be given over to the Perbadanan Putrajaya to manage.

(c) To create an Environmental Unit (EU) within the MDS set-up, by assigning an Environmental Officer and a Technical Assistant to the Unit. The Unit will be responsible for discharging all the environmental regulatory responsibility of the EU specified in the Guide, for development projects in the MDS area.

2.10 CO-ORDINATION BETWEEN REGULATORY AGENCIES

2.10.1 There is a need for co-ordination between the Perbadanan, the 2 local authorities and the various government agencies and departments to manage the development and human activities in the catchment.

2.10.2 The Federal Government has recognised this fact and has formed the *Putrajaya Lake Management Committee (PLMC)* to facilitate this process. However, the PLMC is an administrative Committee and has no legal powers.

2.10.3 **Recommendations:**

(a) A legally constituted Management Committee is recommended to be formed under the Selangor Waters Management Authority Enactment.

(b) The recommended members of the Committee are as follows: (cannot exceed 12 members):

Chairman: State Secretary/Representative
Members:

1) Selangor Waters Management Authority
2) Drainage and Irrigation Department
3) Department of Environment
4) Town and Country Planning Department
5) Perbadanan Putrajaya
6) Majlis Perbandaran Subang Jaya
7) Majlis Daerah Sepang
8) Jabatan Kerja Raya
9) Sewerage Services Department
10) Representative of Stakeholder's Consultative Committee

Secretariat: SWMA/Perbadanan Putrajaya's Lake and Wetlands Unit

(c) The functions of the Committee is to be confined to the integrated management of the catchment*, for the areas outside Putrajaya*.

(d) The Committee has to be formalised by the SWMA eventually. In the interim, the PLMC shall continue to function.

(e) The monitoring functions are to be delegated to the Perbadanan.

(f) A Stakeholder's Consultative Committee is recommended to be formed, comprising representatives from the major stakeholders in the catchment and from Residents' Association.

2.11 MONITORING AND REVIEW

To facilitate the monitoring and review on the effectiveness of the implementation of the Plan the following are recommended:

- Setting-up a hydrological monitoring network
- Setting-up a water quality monitoring network
- Implementing the low-level ICMS

2.12 CATCHMENT MANAGEMENT SYSTEM

To facilitate the implementation and monitoring of the Plan a Catchment Management System comprising of the following 10 elements has been recommended for use by the Lake Catchment Management Committee:

1. Catchment Management Policy
2. Catchment Management Issues
3. Legal and Other Requirements
4. Catchment Management Objectives and Targets
5. Catchment Management Programs
6. Catchment Management Institutional Structure
7. Catchment Community/Stakeholder Participation
8. Awareness and Training Requirements
9. Emergency Preparedness and Response
10. Monitoring and Review

3.0 IMPLEMENTATION SCHEDULE, BUDGET AND FUNDING

3.1 IMPLEMENTATION SCHEDULE AND BUDGET

3.1.1 Table E1 gives the indicative implementation schedule and budget for the various programs recommended by the respective specialists for an implementation period of 3 years.

3.1.2 It can be seen that the total indicative 3-year total cost of the recommended programs is about *RM 26.6 million*, made up of about *RM20.3 million for capital expenditure* and about *RM6.3 million for O&M expenditure*.

3.1.3 The following programs are recommended to be implemented in the first year upon approval of the Lake Catchment Management Plan:

- Water quality monitoring network
- Hydrological monitoring network
- Sewerage effluent discharge monitoring
- Sewerage improvement at UPM

PUTRAJAYA LAKE CATCHMENT DEVELOPMENT AND MANAGEMENT PLAN

	CAPITAL COSTS (RM)					O & M COSTS (RM)					REMARKS
PROGRAMS	**Year 1**	**Year 2**	**Year 3**	**Unscheduled**	**Total**	**Year 1**	**Year 2**	**Year 3**	**Unscheduled**	**Total**	
1. Water Quality Monitoring Network	335,000	425,000	335,000		**1,095,000**	725,000	1,815,000	2,446,400		**4,986,400**	O & M Cost includes
(Refer App. 9.1 for details)											sampling costs
2. Development of groundwater well field				144,000	**144,000**				16,433	**16,433**	To be implemented
(Refer App. 9.2 for details)											when needed
3. Hydrological Monitoring Network	881,000	0	0	881,000	**881,000**	69,000	69,000	69,000		**207,000**	
(Refer App.9.3 for details)											
4. Drainage Improvement Cost											To be implemented
(a) MARDI				8,942,400	8,942,000				56,000	56,000	as part of each
(b) UPM				7,776,000	7,776,000				60,000	60,000	stakeholder's
(c) IOI				72,000	72,000				14,400	14,400	development program
(d) West Country				31,500	31,500				6,300	6,300	
(e) Cyberjaya				81,000	81,000				16,200	**152,900**	
(Refer App. 9.4 for details)					**16,902,900**						
5. Sewerage Improvement/Monitoring Cost											
(a) UPM	854,000				854,000	55,800	55,800	55,800		167,400	
(b) MARDI	240,000				240,000	37,200	37,200	37,200		111,600	
(c) IOI	0				0	9,300	9,300	9,300		27,900	
(d) Cyberjaya	0				0	37,200	37,200	37,200		111,600	
(Refer App. 9.5 for details)					**1,094,000**	139,500	139,500	139,500		**418,500**	
6. ICMS Installation and Improvement	20,500	200,000			**220,500**						
(Refer App. 9.6 for details)											
7. Institutional Strengthening (manpower)						167,000	167,000	167,000		**501,000**	
(Refer App. 9.7 for details)											
TOTAL COSTS	**2,330,500**	**625,000**	**335,000**	**17,927,900**	**20,337,400**	**1,100,500**	**2,190,500**	**2,821,900**	**169,333**	**6,282,233**	

- ICMS Installation
- Institutional Strengthening (additional manpower for MDS)

3.2 FUNDING

3.2.1 The three main sources of funding for the successful implementation of the Consultant's recommendations are:

- The Federal Government
- The Selangor State Government
- The individual stakeholders

3.2.2 Table E2 gives the possible funding sources for the recommended programs.

3.2.3 The capital expenditure is not expected to be recovered. However, there is a need for the respective Local, State and Federal authorities to consider the option of implementing a means of cost recovery for the *funding of the maintenance programs* in the Lake catchment area. The following are two possible equitable policy options for cost recovery:

- Adopt and implement the policy of *"the polluter pays"*
- Adopt and implement the policy of "*the direct beneficiaries pays"*

TABLE E2 POSSIBLE FUNDING SOURCES

FUNDING SOURCE	PROGRAMS	CAPITAL COSTS (RM)	O & M COSTS (RM)	REMARKS
Perbadanan Putrajaya	1. Water Quality Monitoring Network	1,095,000	4,986,400	To be implemented in Year 1 over a 3-year period
	2. Development of groundwater well field	144,000	16,433	To be implemented when needed
	3. Hydrological Monitoring Network	881,000	207,000	To be implemented in Year 1
	4. Sewerage Effluent Monitoring		418,500	To be implemented in Year 1 over a 3-year period
	5. ICMS Installation	20,500		To be implemented in Year 1 for a trial period of 6 months
	6. ICMS Improvement	200,000		To be decided based on 6 month trial
TOTAL COST TO BE BORNED BY PERBADANAN PUTRAJAYA		**2,340,500**	**5,628,333**	
Federal Government	1. Sewerage Improvement Cost	1,094,000		Sewewrage improvement in UPM and MARDI to be implemented in Year 1 (subject to negotiation with UPM and MARDI)
	2. Institutional Strengthening		167,000	1. Annual O&M cost 2. To be implemented in Year 1 3. Subject to negotiation with the Selangor State Government
	3. Drainage Maintenance Cost		152,900	Federal Government to fund maintenance program in areas outside Putrajaya
TOTAL COST TO BE BORNED BY FEDERAL GOVERNMENT		**1,094,000**	**319,900**	
Selangor State Government	Institutional Strengthening		167,000	1. Annual O&M cost 2. To be implemented in Year 1 3. Subject to negotiation with the Federal Government
TOTAL COST TO BE BORNED BY SELANGOR STATE GOVERNMENT			**167,000**	
MARDI	1. Drainage Improvement Cost	8,942,000		To be implemented as part of MARDI's development program
	2. Sewerage Improvement Cost	24,000		Subject to negotiation with Federal Government (to be implemented in Year 1)
TOTAL COST TO BE BORNED BY MARDI		**9,182,400**		
IOI	Drainage Improvement Cost	72,000		
TOTAL COST TO BE BORNED BY IOI		**72,000**		
West Country	Drainage Improvement Cost	31,500		To be implemented as part of each stakeholder's development program
TOTAL COST TO BE BORNED BY WEST COUNTRY		**31,500**		
Cyberjaya	Drainage Improvement Cost	81,000		
TOTAL COST TO BE BORNED BY CYBERJAYA		**81,000**		
SKVE	Drainage Improvement Cost**			
TOTAL COST TO BE BORNED BY SKVE PROJECT		**		To carry out drainage improvement in UPM and MARDI areas which are affected by the respective project **Costs cannot be ascertained
ERL	Drainage Improvement Cost**			
TOTAL COST TO BE BORNED BY ERL PROJECT		**		
UPM	1. Drainage Improvement Cost	7,776,000		To be implemented as part of UPM's development program
	2. Sewerage Improvement Cost	854,000		Subject to negotiation with Federal Government (to be implemented in Year 1)
TOTAL COSTS TO BE BORNED BY UPM		**8,630,000**		

*S*ummary

SUMMARY

1.0 STUDY BACKGROUND

1.1 VISION FOR PUTRAJAYA

Putrajaya is envisaged to be developed into a "City in a Garden" with the 552 hectares Putrajaya Lake (see Figure 1) as its focal point. The Lake is required to cater for multi-functional uses and thus has to be always in pristine condition, with a high water quality.

1.2 STUDY OBJECTIVES

To achieve and maintain the high water quality objective set for Putrajaya Lake there is a need to:

(a) Prepare a Comprehensive Catchment Development and Management Plan for the Putrajaya Lake Catchment, which shall include the following:

- Land-use Masterplan
- Drainage Masterplan
- Sewerage Masterplan

(b) Define the details of the implementation requirements for the Plan, as listed below.

- Planning and Land-use Controls
- Drainage Management and Controls
- Environmental Management and Pollution Control
- Co-ordination between Regulatory Agencies
- Monitoring
- Funding

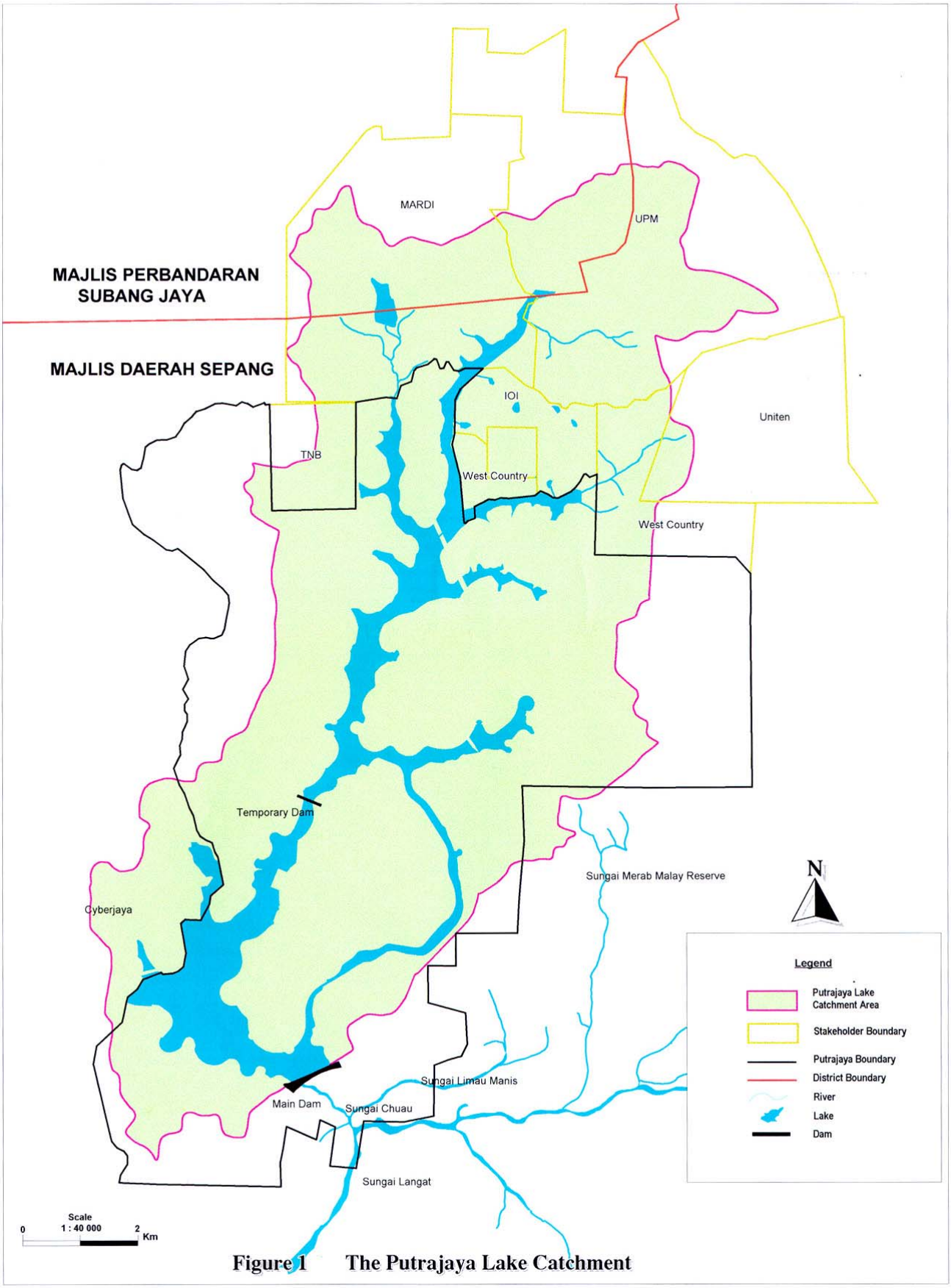


Figure 1 The Putrajaya Lake Catchment

2.0 CATCHMENT MANAGEMENT ISSUES & RECOMMENDATIONS

2.1 WATER QUALITY MANAGEMENT

2.1.1 It is recognised that the most effective way to attain the desired water quality objective for the Lake is to *minimise the generation of pollutants at their source*. This is especially important during the implementation of any development works in the catchment, where the erosion rate (estimated to be about 600 ton/ha/yr. without surface cover) and transport of sediments from the land clearing, earthworks and construction activities, can cause significant increase in the Total Suspended Solids (TSS) in the Lake waters.

2.1.2 **Recommendations:**

- To enhance the water quality in the Lake the wetlands should be integrated with upstream water quality enhancement features, such as vegetated landscape riparian buffers, drainage corridors and upstream mini-wetlands flood detention ponds.

- The drainage system, comprising of concrete drains connected to gross pollutant/sediment trap outlets to the Lake should not be the norm, but rather they should be the exception. The norm should be vegetated landscape drainage corridors coupled with mini wetlands flood detention ponds. Compliance should not be too difficult since JPS/JPBD has a guideline that 3 - 5% of a proposed development area should be reserved for detention ponds.

- To ensure a "rubbish-free" drainage corridor, gross pollutant/sediment trap (GPT) structures are to be installed at the ends of all concrete drains flowing into the vegetated landscape drainage corridors.

- To ensure effective control of erosion and sediment during earthworks it is recommended that:

  (a) A new "Erosion and Sediment Control By-Law" be

enacted by the Perbadanan and the Majlis Daerah Sepang. The By-Law will make it mandatory that a comprehensive erosion and sediment control plan be prepared and implemented during the earthworks. It will supercede the current Earthworks By-Law which is found to be inadequate for on-site erosion and sediment control.

(b) The recommended By-Law should be supported by a new "Standards for Erosion and Sediment Control" Manual. The new manual should describe in detail the specifications and design standard for erosion and sediment control.

2.2 POLLUTANT SOURCES MANAGEMENT

2.2.1 Point Pollutant Sources

2.2.1.1 The following point sources, arising from sewage effluent, have been identified:

- Sewage effluent discharge from MARDI (wetlands)
- Sewage effluent discharge from UPM (wetlands)
- Sewage effluent discharge from IOI (wetlands)
- Sewage effluent discharge from Cyberjaya Flagship Zone (Phase 2 Lake)

Solution: They will be managed in the sewerage masterplan.

2.2.1.2 A **potential point source** that may pose a threat to the water quality in the Lake, may arise from accidents associated with the oil tankers moving along the road passing through the wetlands.

Recommendation: It is recommended that the pertinent authorities (JKR, Perbadanan) ensure that Emergency Response Plans and Procedures are prepared and implemented to handle such potential emergencies.

2.2.2 Non-point Pollutant Sources

The following are the non-point pollutant sources:

(a) Runoffs from the road passing through the wetlands
Solution: The drainage system from the road shall be integrated into the drainage masterplan.

(b) Runoffs from within Putrajaya area entering directly into the Lake
Solution: It is recommended that vegetated drainage corridors coupled with mini-wetland flood detention pond drainage systems be used.

(c) Fertiliser and pesticide inputs from MARDI, UPM, IOI and Cyberjaya Flagship Zone
Solution: BMP guidelines on the use of fertilisers and pesticides have been prepared and are to be followed by the above stakeholders.

2.3 WATER QUANTITY MANAGEMENT

It is important that all possible runoff arising from the Lake catchment should enter into the Lake system. The following are pertinent issues:

(a) **Water Losses** - The geological and hydrogeological study has concluded that:

- There will be no significant losses through the hard rock.
- There will be no losses through the peat layers connecting Cyberjaya and Putrajaya.
- There will be no losses due to seepage under the Main dam.
- There will be no significant losses through the Alluvium aquifer.

(b) **Irrigation Water Demand** - The Perbadanan is planning to use the water in the Lake for the irrigation of the landscaped

vegetation in the numerous parks within Putrajaya. There is a need to evaluate the impact on the water quality in the Lake due to the water withdrawal from the Lake for irrigation purposes. *The situation is especially critical during a drought when irrigation demand is highest and there is no water inflow into the Lake.*

(c) **Recommendations:**

- No diversion or alteration of the natural drainage lines in the catchment is to be allowed.
- Compensation flow *equal to 10% of the Annual Average Flow* may be allowed during the in-filling of the main dam.
- A well field of 6 groundwater wells can be developed, downstream of the main dam, to supply 0.013 m^3/s (10,000 g/hr) of groundwater to meet any water demand.
- A separate irrigation masterplan study has to be carried out, which shall include a study on the impact of the proposed rainwater harvesting within the catchment on the water quantity in the Lake.

2.4 LAND-USE PLANNING

2.4.1 The major land parcels in the catchment areas outside Putrajaya are:

- UPM
- MARDI
- IOI
- TNB
- West Country Bhd
- UNITEN
- Sungai Merab Malay Reserve
- Cyberjaya Flagship Zone

To ensure that the development in the above areas are in line with the objectives for the catchment a land-use masterplan for the areas outside Putrajaya has been prepared.

2.4.2 Recommended Land-use Masterplan

Figure 2 and Table 1 show the recommended land-use masterplan for the areas outside Putrajaya. Also, Table 2 shows the Use-Class Order Tables describing the allowable land-use activities in each of the land parcels.

2.5 DRAINAGE PLANNING

2.5.1 A drainage masterplan has been developed for Putrajaya. There is a need to integrate the existing, committed and future drainage plans in the catchment areas outside Putrajaya, with the Putrajaya drainage masterplan.

2.5.2 The Drainage Masterplan comprises of:

- Drainage Planning and Design Guidelines
- Specific recommendations for upgrading the drainage systems in five of the major land parcels outside Putrajaya, so as to integrate them into the Putrajaya drainage masterplan.

2.5.3 Recommended Drainage Planning and Design Guidelines

- The Putrajaya Stormwater Management Design Guide and JPS new Drainage Design Manual (to be published in 2000) should be made applicable for all drainage design in the catchment.
- The drainage system is to be based on vegetated landscape drainage corridors and the conversion of flood detention and water quality enhancement ponds into mini-wetlands. The typical profile and design schematic, respectively, of mini wetlands cum detention ponds are shown in Figures 3 and 4, respectively.
- All drainage lines flowing directly into the Lake should terminate at ponds converted into mini-wetlands, before flowing into the Lake.
- GPTs shall be provided at all concrete drain outlets flowing into the vegetated landscape drainage corridors.

FIGURE 2
PROPOSED INTEGRATED LANDUSE MASTERPLAN

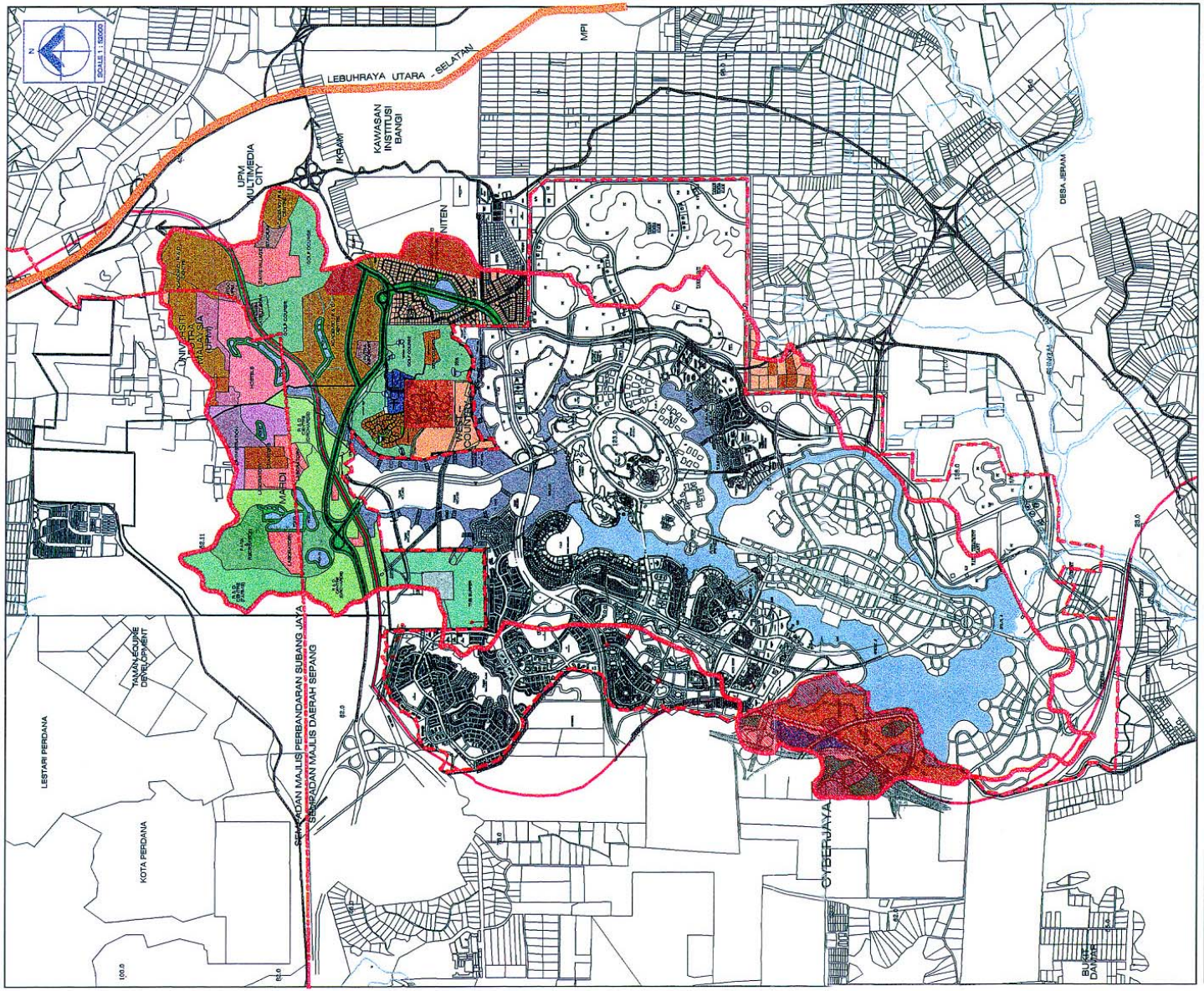


FIGURE : 2

TITLE : PROPOSED INTEGRATED LANDUSE MASTERPLAN

CATCHMENT DEVELOPMENT AND MANAGEMENT PLAN FOR PUTRAJAYA LAKE

LEGEND :-

BUILDINGS	EXISTING	ACRE	COMMITTED	ACRE	PROPOSED	ACRE	FUTURE LANDUSE	%
HOUSING / QUARTERS		101.47		197.47		303.46	596.91	32.71
COMMERCIAL		17.46		12.15		-	29.61	1.62
HOSTELS/COLLEGE		59.76		-		153.92	213.68	11.67
TNB POWER STATION		28.95		-		-	28.95	1.58
ADMINISTRATION/OFFICE		71.12		66.45		80.26	217.83	11.90
ACADEMIC/R & D		-		-		406.69	406.69	22.22
FACILITIES		92.35		66.06		165.27	343.68	18.29
TOTAL		371.11		369.13		1100.74	1830.96	41.77
GREEN								
AGRICULTURE		542.33		-		-	-	
GOLF COURSE		403.41		-		403.41	403.41	26.23
BUFFER ZONE		194.03		-		25.75	219.78	13.84
ORCHARDS		742.96		-		354.96	354.96	22.20
FARMS		723.86		-		141.21	141.21	8.83
OPEN SPACE/RECREATION		246.23		117.29		103.30	506.69	29.91
TOTAL		2970.23		117.29		1061.72	1699.06	30.49
WATER BODIES								
LAKE/POND		63.28		51.00		42.22	156.53	76.91
WETLAND		46.99		-		-	46.99	23.09
TOTAL		110.27		51.00		42.22	203.52	4.64
OTHERS								
ROAD/DRAINAGE		242.85		-		-	242.85	32.42
EXPRESS RAIL LINK		-		157.95		-	157.95	21.09
HIGHWAY		-		277.96		-	277.96	41.89
OTHERS		34.48		-		-	34.48	4.60
TOTAL		277.33		471.76			749.09	17.09
GRAND TOTAL							4382.06	100.00

BOUNDARY	ACRE	HECTAR
PUTRAJAYA	10,600	4,289.67
SURROUNDING PUTRAJAYA	4,382.06	1,773.37
TOTAL LAKE CATCHMENT	14,982.06	6,063.04

TABLE 1 : 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	59.48	-	-	-	-	-	-	66.45	27.40	-	-	-	-	217.83	11.90
Hostels/College	213.68	29.52	-	-	-	-	-	-	-	-	-	-	-	-	-	-	213.68	11.67
Housing/Quarters	-	-	19.30	7.58	132.20	82.14	-	-	236.26	100.00	121.45	50.00	89.60	100.00	-	-	598.81	32.71
Commercial	-	-	-	-	17.46	10.86	-	-	-	-	12.15	5.01	-	-	-	-	29.61	1.62
Academic/R&D	312.89	43.23	-	-	-	-	-	-	-	-	-	-	-	-	93.80	100.00	406.69	22.22
Power Station	-	-	-	-	-	-	28.95	100.00	-	-	-	-	-	-	-	-	28.95	1.58
Facilities	197.25	27.25	83.82	32.94	11.27	7.00	-	-	-	-	42.48	15.02	-	-	-	-	334.82	18.29
TOTAL	723.82	50.94	254.50	22.16	160.93	30.77	28.95	12.98	236.26	61.96	242.53	39.96	89.60	100.00	93.80	100.00	1,830.39	41.77
B. GREEN AREAS																		
Open Space/Field Recreation	189.66	49.28	155.02	23.59	5.82	2.61	-	-	17.66	-	110.06	100.00	-	-	-	-	478.22	29.91
Golf Course	186.51	48.46	-	-	216.90	97.39	-	-	-	-	-	-	-	-	-	-	403.41	25.23
Farms	-	-	141.21	21.49	-	-	-	-	-	-	-	-	-	-	-	-	141.21	8.83
Orchards	-	-	354.96	54.01	-	-	-	-	-	-	-	-	-	-	-	-	354.96	22.20
Buffer Zone	8.67	2.25	6.01	0.91	-	-	194.03	100.00	5.34	23.22	7.23	-	-	-	-	-	221.28	13.84
TOTAL	384.84	27.09	657.20	57.22	222.72	42.59	194.03	87.02	23.00	6.03	117.29	19.32	-	-	-	-	1,599.08	36.49
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	31.68	24.47	89.63	-	-	55.27	53.26	48.22	24.58	-	-	-	-	242.85	32.42
Express Rail Link	73.86	29.13	48.32	28.71	-	-	-	-	-	-	35.77	18.23	-	-	-	-	157.95	21.09
Highway	118.08	46.58	66.68	39.62	-	-	-	-	47.20	45.49	81.85	41.72	-	-	-	-	313.81	41.89
Others	-	-	-	-	2.83	10.37	-	-	1.30	1.25	30.35	15.47	-	-	-	-	34.48	4.60
TOTAL	253.51	17.84	168.32	14.66	27.30	5.23	-	-	103.77	27.21	196.19	32.32	-	-	-	-	749.09	17.09
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

TABLE 2: LAKE CATCHMENT LANDUSE MASTERPLAN – USE CLASS ORDER

LAKE CATCHMENT AREA (PLOT)	PERMITTED USE	PERMITTED WITH CONDITION		NON PERMITTED USE
UPM	**INSTITUTIONAL**	**Activities**	**Conditions**	
Institutional Centre Total Area: 1,420.86 acre	• Hostels/College • Faculty • Administration Centre • R&D Centre • Farms & Orchards • Open Space/Feild • Library • Laboratory	• Hospital • Staff Quarters • Supporting Commercial - Bank, Shop, Food court, clinic etc. • Mosque • Pedestrian walk • Buffer Zone • Sewage Treatment Plant • Road/Drainage • Highway/ERL	• 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 • Fetilizer & 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	• 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
MARDI	**REASEARCH CENTRE**	**Activities**	**Conditions**	
Research Centre Total Area: 1,148.52 acre	• Administration Office • R&D Centre • Laboratory • Store • Farms & Orchards • Nursery	• Staff Quarters • Hostels • Supporting Commercial - Canteen, Food court, etc. • Buffer zone • Recreation/Open Space • Lake/pond • Road/Drainage • Highway/ERL	• 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	• 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	• Low Density Housing - Bungalow lots • Sports and recreations • Open Space/Feild	• Neighbourhood Commercial - Club House - Nursery Centre - Health Club - Shops - Clinic • Golf Course • Road/Drainage	• 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 • Fetilizer & 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	• 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	• Power Plant • Green Network - Reserve for electric line - Buffer Zone	• Recreation • TNB Facilities • Open Space/Feild	• 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	• Any development accept TNB use
WEST COUNTRY BHD.	**HOUSING**	**Activities**	**Conditions**	
Housing Total Area: 381.33 acre	• Low Density Housing - Bungalow lots • Sports and recreations •	• Neighbourhood Commercial - Shops, Clinic etc. • Institutional • Lake/pond • Sewage Treatment Plant • Road/Drainage • Highway	• 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 • Fetilizer & 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	• 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	• Low & Medium Density Housing • Commercial - shops, clinic, bank, food court etc. • Offices • Open Space/Feild •	• Institutional • Commercial • Public facilities • Recreation • Lake/pond • Sewage Treatment Plant • Road/Drainage • Highway/ERL	• 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 • Fetilizer & 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	• 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	• Hostels/College • Faculty • Administration Centre • R&D Centre • Farms & Orchards • Open Space/Feild • Library • Laboratory	• Staff Quarters • Supporting Commercial - Bank, Shop, Food court, clinic etc. • Mosque • Pedestrian walk • Buffer Zone • Sewage Treatment Plant • Road/Drainage • Highway/ERL	• 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 • Fetilizer & 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	• 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	• Low Density Housing - Bungalow lots - Cluster - Semi Detached	• 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	• To comply with Guidelines - Planning Standard, Lake Catctment, 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 • Fetilizer & 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	• 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)

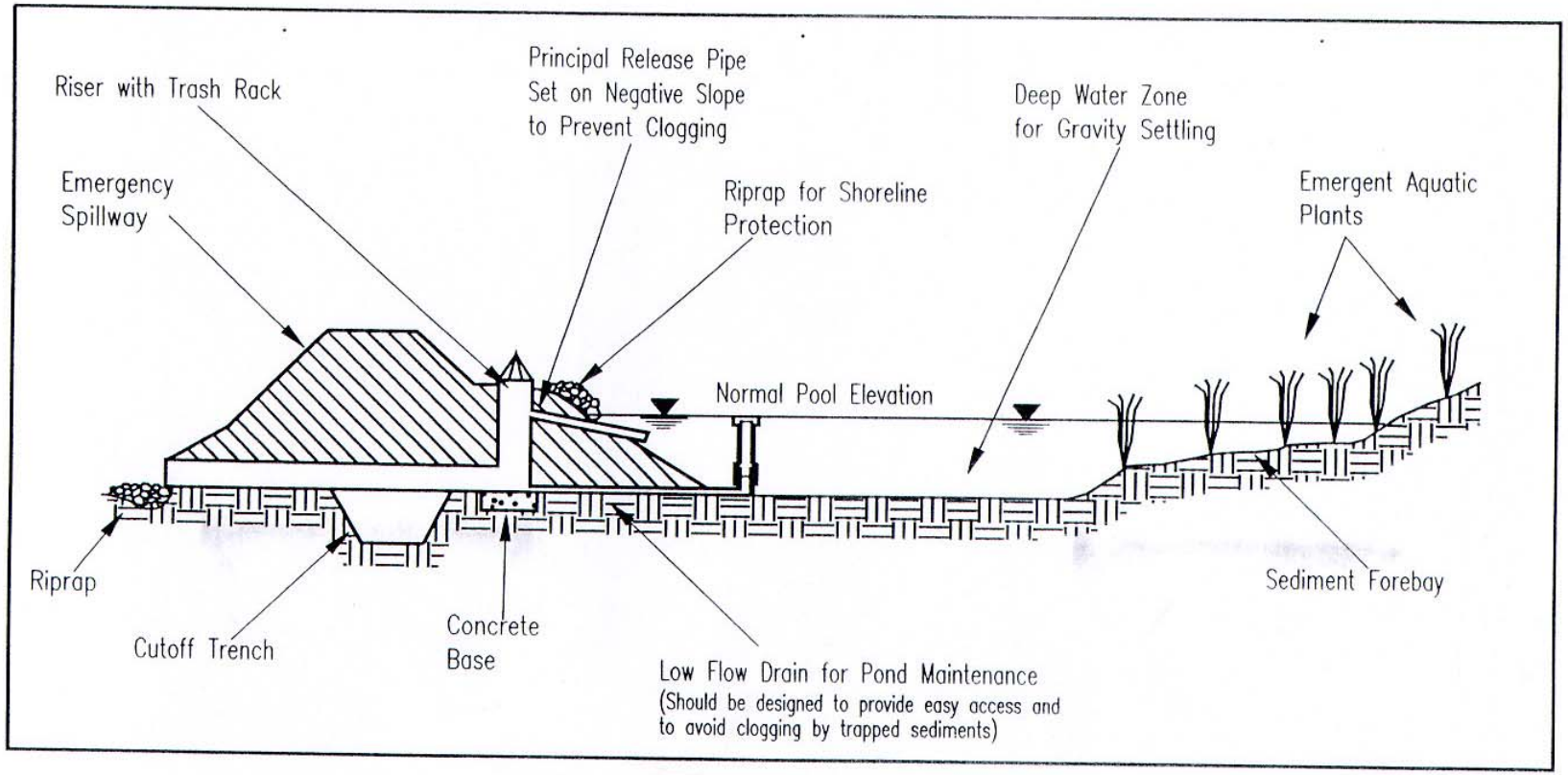


Figure 3 Typical wet pond profile.
(Source: Engineers & Surveyors Institute and Northern Virginia District Planning District Commision)

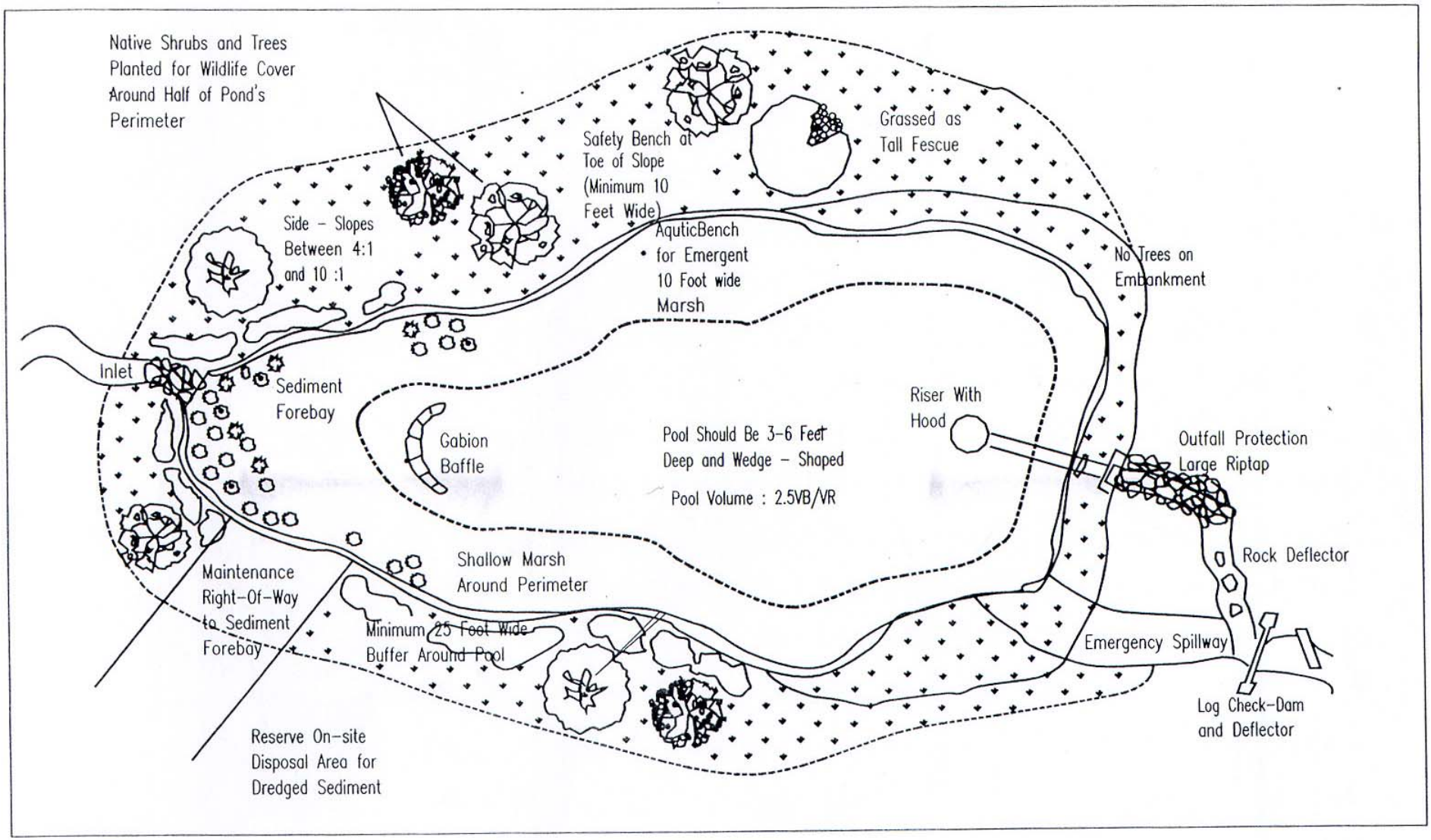


Figure 4 Design schematic of a wet pond. (Source: Schueler, 1987)

2.5.4 Recommended Drainage Masterplan

2.5.4.1 UPM (See Figure 5)

(1) The existing streams in the UPM areas should be preserved and be provided with vegetated landscape riparian buffers.

(2) The drainage systems of the proposed ERL and SKVE are to be integrated to the existing streams in the area. In the integration process all existing streams in the UPM area that are affected by the proposed construction works are to be upgraded with the provision of vegetated landscape riparian buffers. Also, the drainage system connecting the ERL and SKVE to the vegetated landscape streams are to be provided with GPTs and sediment traps. *The situation is especially urgent since the land clearing and earthwork phase for the SKVE and ERL in the area has already started.*

2.5.4.2 MARDI (See Figure 6)

(1) The existing streams in the MARDI areas should be preserved and be provided with vegetated landscape riparian buffers.

(2) There is a need to integrate the proposed ERL and SKVE drainage systems into the existing drainage system, which eventually flows into the Upper West wetlands. *The situation is especially urgent since the land clearing and earthwork phase for the SKVE and ERL in the area has already started.*

(3) In the integration process it is recommended that all existing streams in the MARDI area that are affected by the proposed construction works are to be upgraded with the provision of vegetated landscape riparian buffer and mini wetlands cum detention ponds, where pertinent. Also, the drainage system connecting the ERL and SKVE to the vegetated landscape streams are to be provided with GPTs and sediment traps.

2.5.4.3 IOI (See Figure 7)

It is recommended that the culverts/drains connecting the 3 ponds discharging into the Putrajaya wetlands be provided or replaced with earth-drains coupled with vegetated landscape drainage buffers.

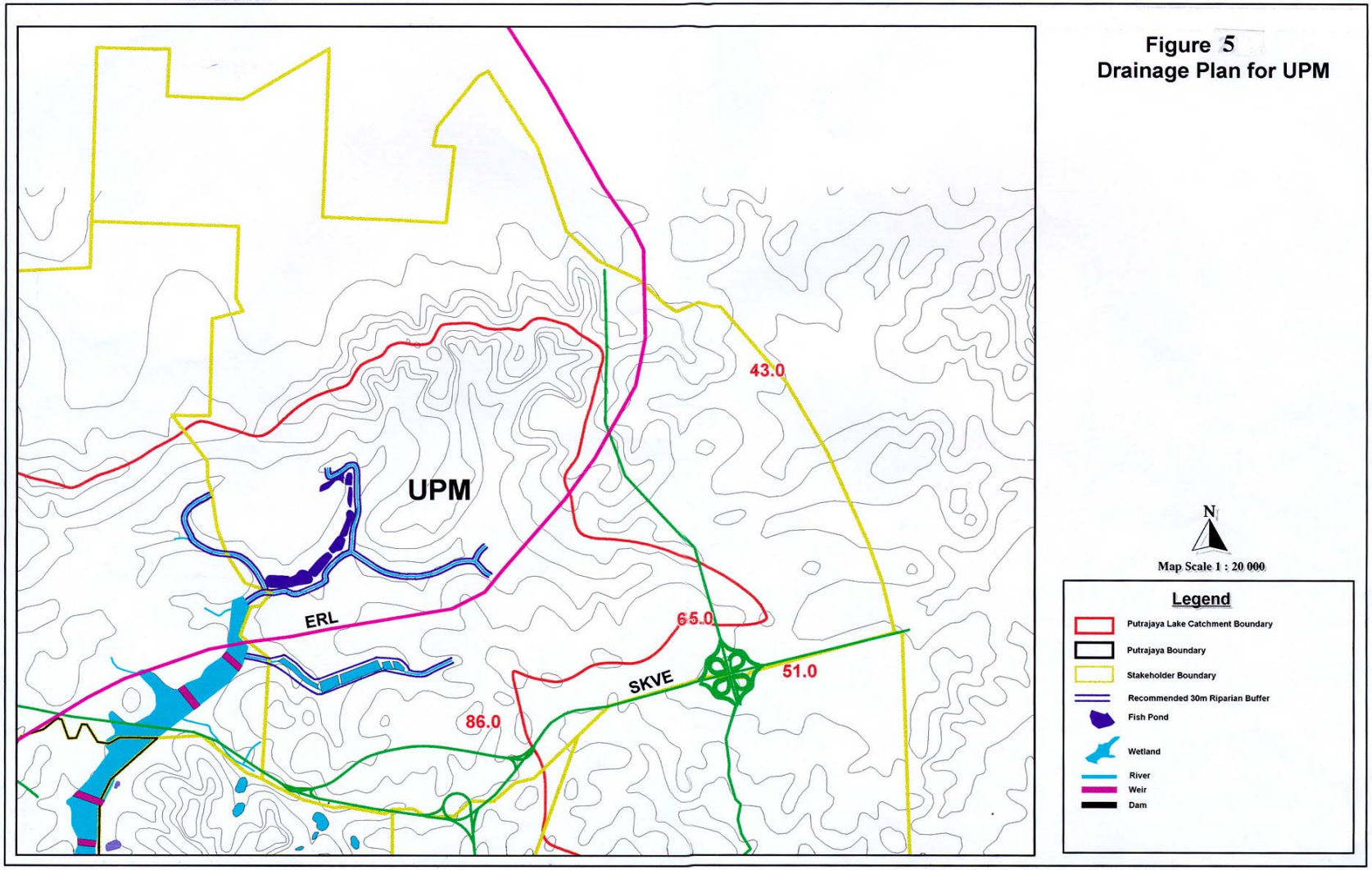


Figure 5
Drainage Plan for UPM
UPM
ERL
SKVE
43.0
65.0
51.0
86.0
N
Map Scale 1 : 20 000
Legend
Putrajaya Lake Catchment Boundary
Putrajaya Boundary
Stakeholder Boundary
Recommended 30m Riparian Buffer
Fish Pond
Wetland
River
Weir
Dam

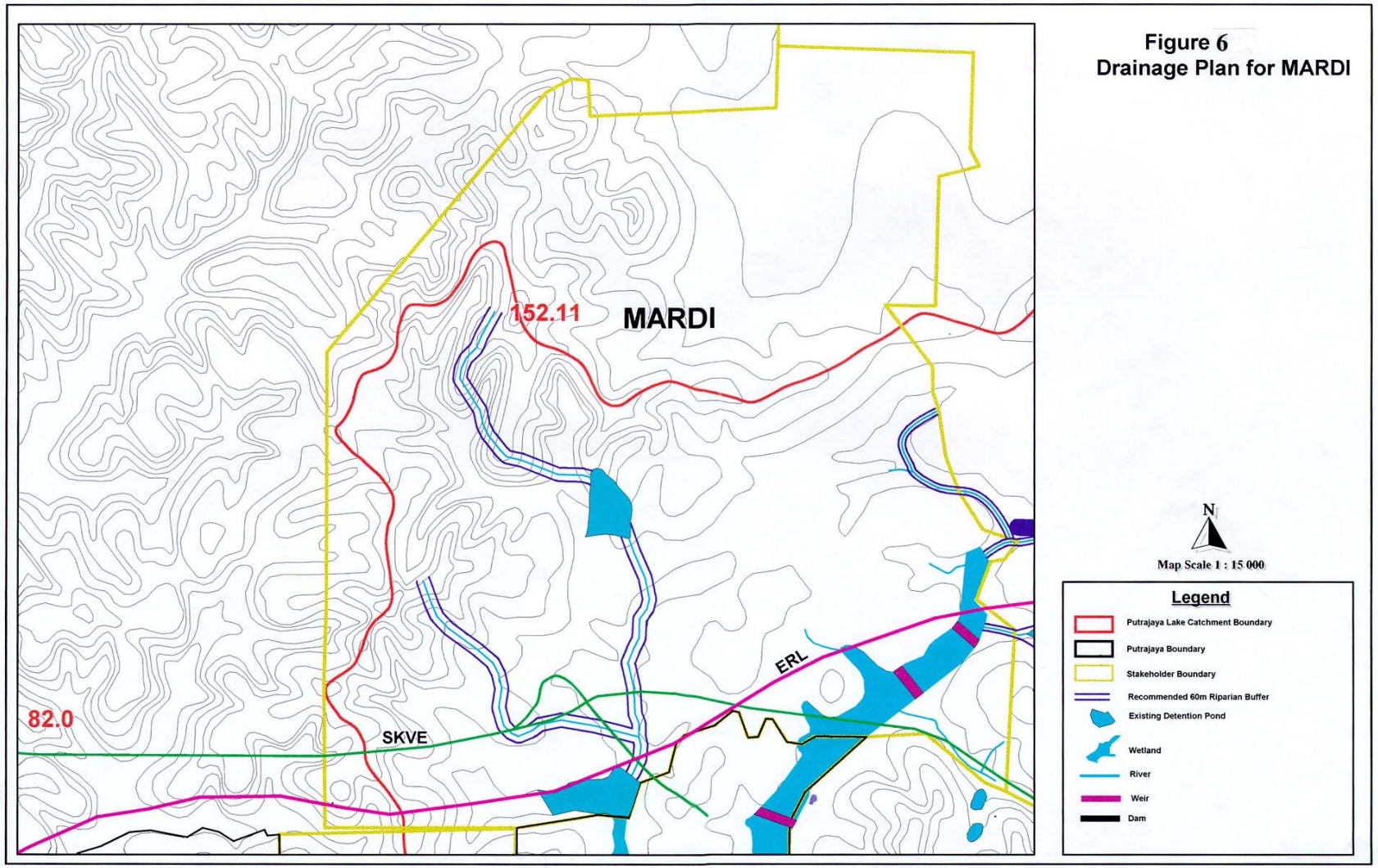


Figure 6
Drainage Plan for MARDI

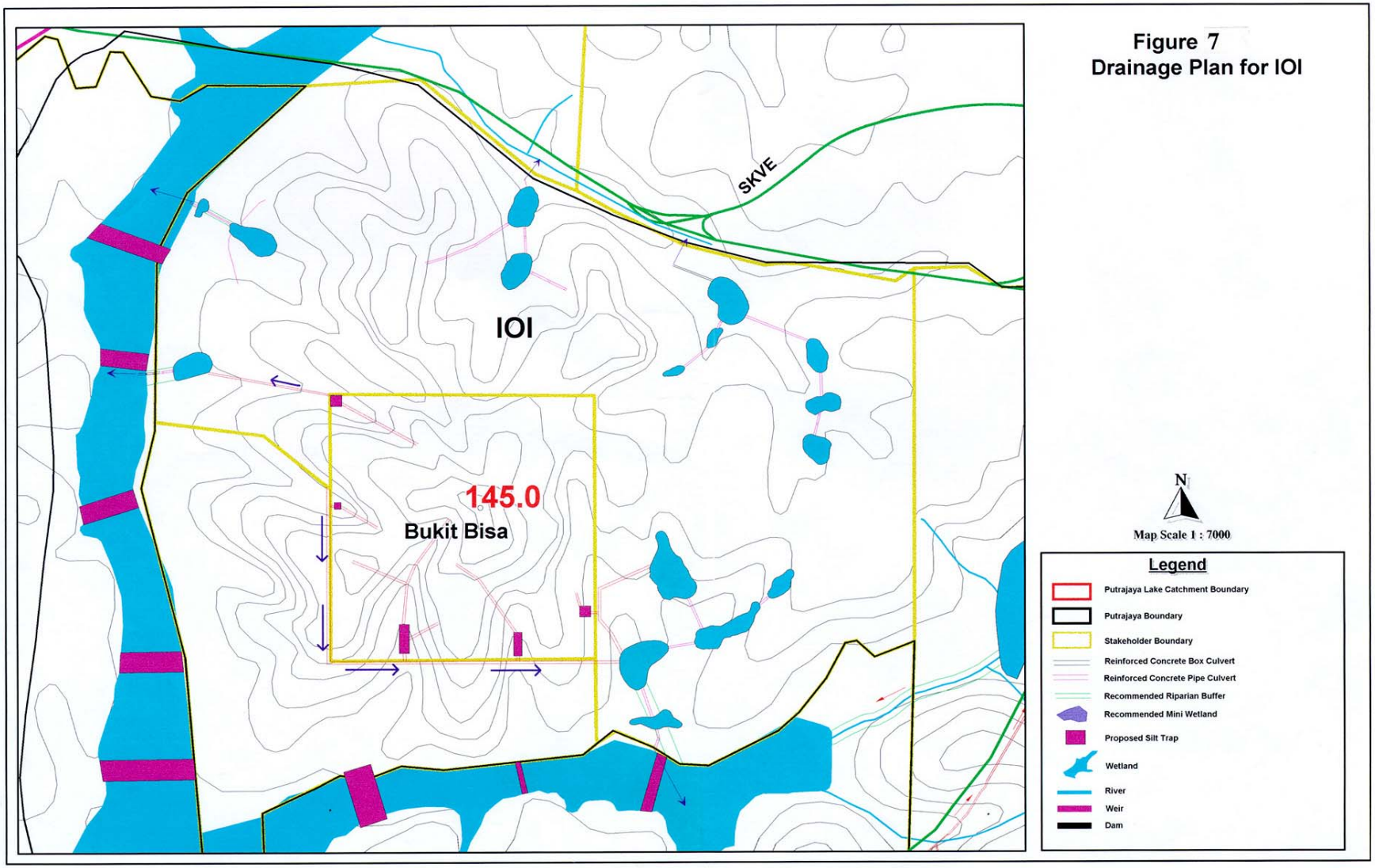


Figure 7
Drainage Plan for IOI

2.5.4.4 West Country Berhad (See Figure 8)

(1) The proposed drainage system for this area comprises of a 4.4 ha (11 acres) flood detention and recreational lake cut into two parts by the proposed Putrajaya-SKVE access road. A concrete drain has been proposed to replace the existing stream connecting the downstream lake with the Putrajaya wetland.

(2) It is recommended that the proposed lake should be created without any major earthworks by using the existing contours of the land.

(3) It is recommended that the existing stream connecting the downstream part of the lake to the Putrajaya wetland should be preserved and converted into a vegetated drainage corridor. Also, all the concrete drains in the proposed drainage system leading into the two parts of the lake are to be provided with GPTs.

2.5.4.5 Cyberjaya Flagship Zone (See Figure 9)

(1) The proposed drainage system by the Cyberjaya consultant makes all runoff flows into proposed water quality enhancement ponds before discharge into the Putrajaya Lake. To remove gross pollutants from the runoff GPTs have been provided in all outlets into the ponds.

(2) To improve the quality of the runoff flowing into the Lake the Consultant recommends that, the drainage system should be based on vegetated landscape drainage corridors and conversion of the water quality enhancement ponds into mini-wetlands. Also, all drainage lines should terminate at water quality enhancement ponds converted into mini-wetlands.

2.6 SEWERAGE PLANNING

2.6.1 The sewerage masterplan comprises of:

(a) Sewerage Planning and Design Guidelines
(b) Specific recommendations for the management of the sewage effluent discharge from MARDI, UPM, IOI and Cyberjaya.

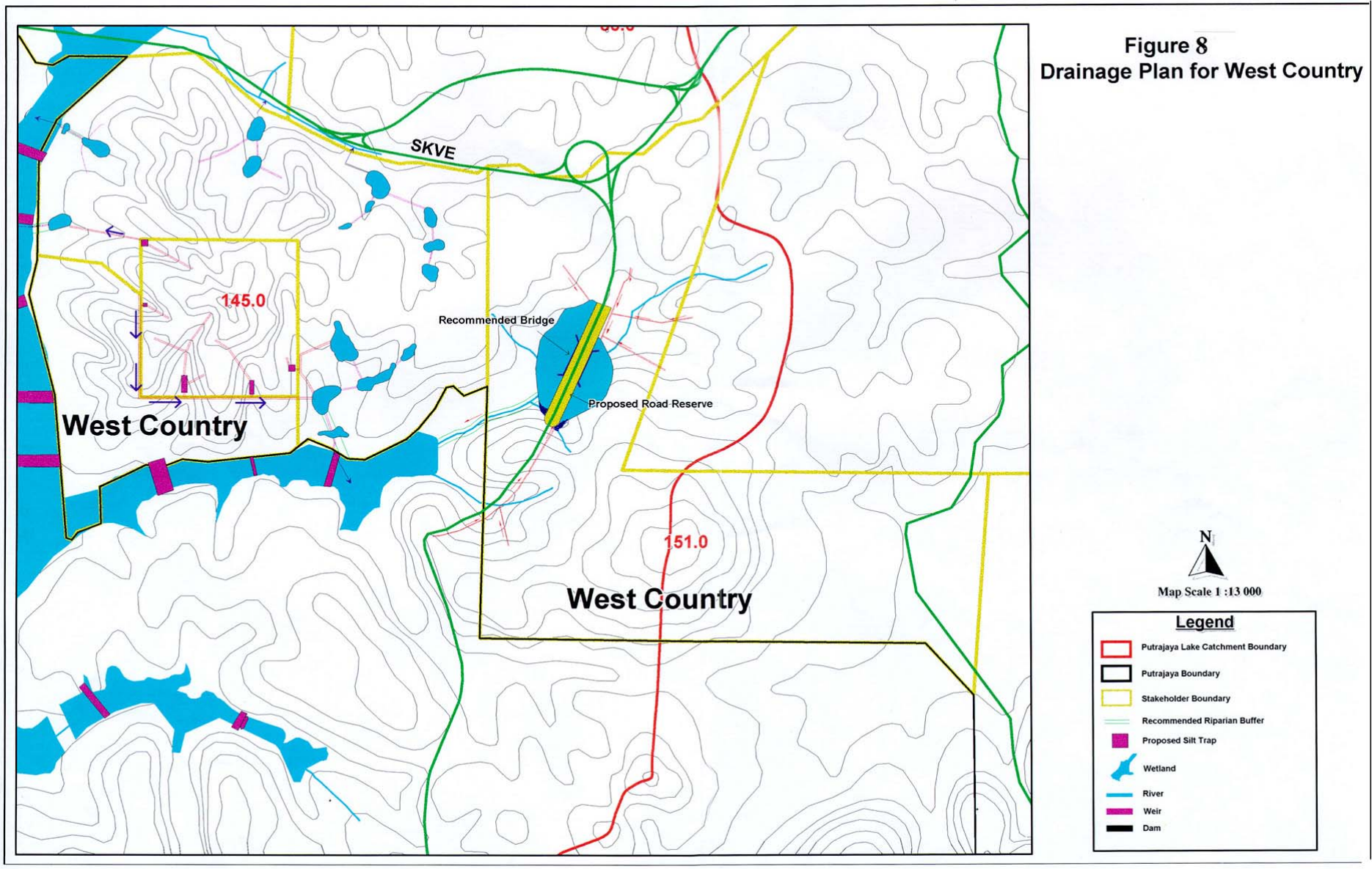


Figure 8
Drainage Plan for West Country

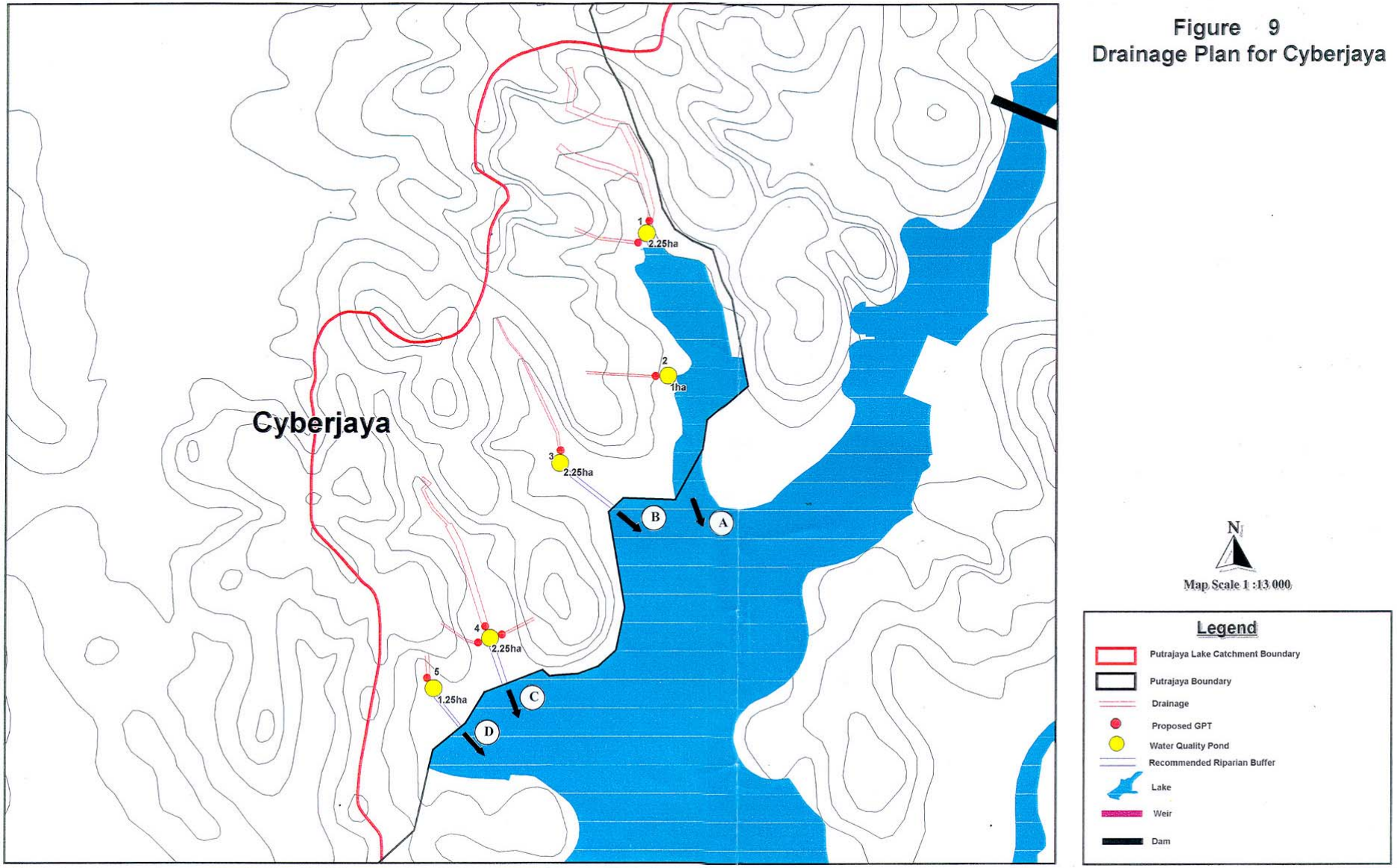


Figure 9
Drainage Plan for Cyberjaya

2.6.2 Recommended Sewerage Planning and Design Guidelines

- The sewage effluent quality shall meet the Putrajaya effluent quality standard, which is given in Appendix 1, together with the parameter values of 3 other water quality standards.
- All treated sewage effluents from new developments in the catchment shall be channelled outside the Putrajaya Lake catchment.
- All existing treated effluents are to be directed into the Putrajaya Wetlands or detention ponds/mini wetlands.

2.6.3 Recommended Sewerage Masterplan *(see Figure 10)*

2.6.3.1 MARDI

The existing sewage flows of 600 PE and the sewage flows from future developments in MARDI are to be connected to a recommended new central sewage treatment plant, that will be shared with UPM.

2.6.3.2 UPM

(1) The sewage treatment facilities for Kolej 8 (1,097 PE) and Kolej 9 (1,038 PE) are unsatisfactory. It is recommended that they be upgraded as part of the recommended new UPM-MARDI central sewage treatment plant

(2) The recommended UPM-MARDI central sewerage treatment plant can be integrated into the Indah Water Konsortium (IWK) sewerage development plan for the Kota Perdana/ Listari sewerage sub-catchment in the Petaling district later.

2.6.3.3 IOI

(1) The present central sewage treatment plant of capacity 7,761 PE, which is under construction, has been approved by Jabatan Perkhidmatan Pembentungan (JPP).

(2) The quality of the combined surface runoff and treated effluent discharge at the outlet of its retention pond should be monitored. Upgrading of the system with supplementary processes for the removal of nutrients (TN and TP) maybe necessary based on the results from the monitoring.

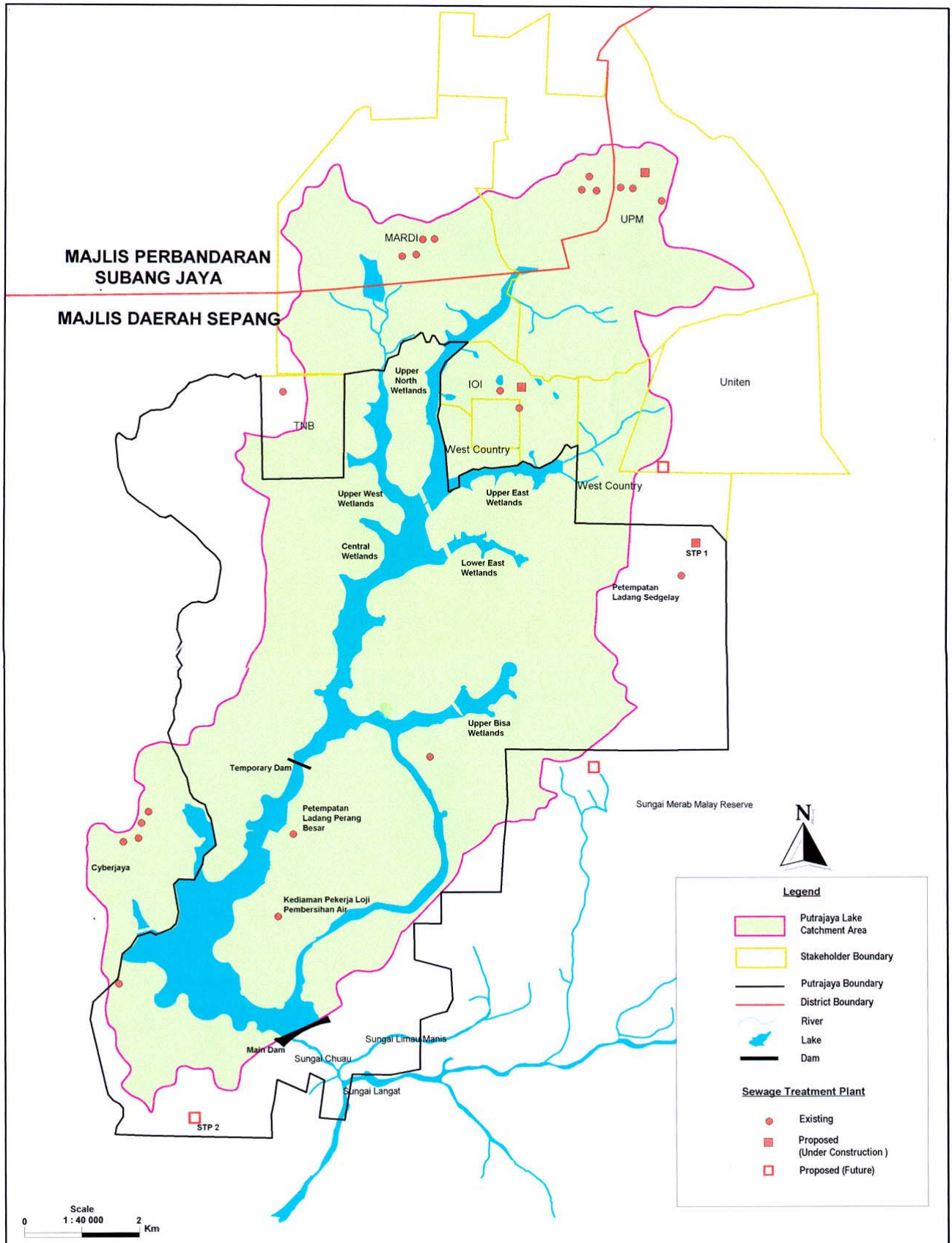


Figure 10 Location of Existing and Proposed Sewage Treatment Plants

2.6.3.4 Cyberjaya

(1) The sewage flows from the Cyberjaya area, within the Lake catchment, will eventually be transferred for treatment outside the catchment in accordance with the overall sewerage masterplan for Cyberjaya.

(2) However, in the interim four temporary sewage treatment plants are used to treat the sewage flows from the development. The treated effluents from the plants are discharge into open drains that lead to the Phase-2 Lake. Presently, there is no impact because the Phase-2 Lake is not constructed yet.

(3) When the Phase-2 Lake is formed, the treated effluents from the existing temporary sewage treatment plants shall be collected and transferred outside the lake catchment.

2.7 PLANNING AND LAND-USE CONTROL

Planning and land use control of areas within the catchment represents one of the most important mechanisms for the protection of the water quality in the Lake. The mechanism and set-up for control and management of planning in the Majlis Daerah Sepang (MDS) and Majlis Perbandaran Subang Jaya (MPSJ) is not as well organised as in Putrajaya.

Recommendations:

(a) To develop and gazette local plans for the land parcels outside Putrajaya. This will be carried out by the JPBD as part of the local plan for the MSC Area.
(b) To implement similar planning submission and approval process requirements as those in the Perbadanan, for all proposed development projects in the catchment areas of the Majlis Daerah Sepang (MDS).
(c) To assign an additional Planner and Technical Assistant to the MDS to cope with the increase workload due to the additional work arising from the implementation of the detailed planning submission requirements above.

2.8.1 DRAINAGE MANAGEMENT AND CONTROL

There is no integrated approach to this issue since the responsibilities for drainage lies with the JPS, the local authorities and other agencies such as the JKR and other developers.

Recommendations:

(a) To require all development projects, including utilities and transportation projects to comply with the recommended drainage concept and design guidelines for the Putrajaya Lake catchment.
(b) To assign an additional Civil Engineer and Technical Assistant to the MDS so that they can give special attention to drainage and earthworks for developments in the Putrajaya Lake catchment areas.

2.9 ENVIRONMENTAL MANAGEMENT AND POLLUTION CONTROL

There is presently no organisational set-up in the MDS and MPSJ to effectively manage environmental issues, such as control of water pollution, runoff management and others that affect the Lake water quality.

Recommendations:

(a) To implement the requirements of the Putrajaya Environmental Management Guide for all development projects in the Putrajaya Lake catchment.
(b) To ensure integrated management of the Lake waterfront environment it is recommended that the 20-metre green zone buffer along the Lake in the Cyberjaya area be given over to the Perbadanan Putrajaya to manage.
(c) To create an Environmental Unit (EU) within the MDS set-up, by assigning an Environmental Officer and a Technical Assistant to the Unit. The Unit will be responsible for discharging all the environmental regulatory responsibility of

the EU specified in the Guide, for development projects in the MDS area.

2.10 CO-ORDINATION BETWEEN REGULATORY AGENCIES

There is a need for co-ordination between the Perbadanan, the 2 local authorities and the various government agencies and departments to manage the development and human activities in the catchment. The Federal Government has recognised this fact and has formed the *Putrajaya Lake Management Committee (PLMC)* to facilitate this process. However, the PLMC is an administrative Committee and has no legal powers.

Recommendations:

(a) Formation of a Management Committee under the SWMAE

1. The legislative review carried out recommended that the Putrajaya Lake catchment be classified as a designated sub-catchment for water source protection under the *Selangor Waters Management Authority Enactment (SWMAE)*. The SWMAE is the most appropriate legal vehicle for integrated catchment management.

2. Article 46(1) (d) of the SWMAE allows the SWMA to *establish local area management committees* and *stakeholders groups* to work with the SWMA in the management of a designated water source or sub-catchment. Thus, it is recommended that a Management Committee be formed to work with the Selangor Waters Management Board to manage the catchment.

   Article 46 (SWMAE) - Implementation of integrated management plans
   "(1) Notwithstanding anything to the contrary contained in any written law, the Authority -
   (a) …….
   (d) may establish local area management committees and stakeholder groups to work with the Authority;"

The proposed structure for the management of the Lake catchment is shown in Figure 11.

(b) The Management Committee

1. It is recommended that the members of the Committee be made up of representatives from the following: (cannot exceed 12 members):

Chairman: State Secretary/Representative
Members:

1) Selangor Waters Management Authority
2) Drainage and Irrigation Department
3) Department of Environment
4) Town and Country Planning Department
5) Perbadanan Putrajaya
6) Majlis Perbandaran Subang Jaya
7) Majlis Daerah Sepang
8) Jabatan Kerja Raya
9) Sewerage Services Department
10) Representative of Stakeholder's Consultative Committee

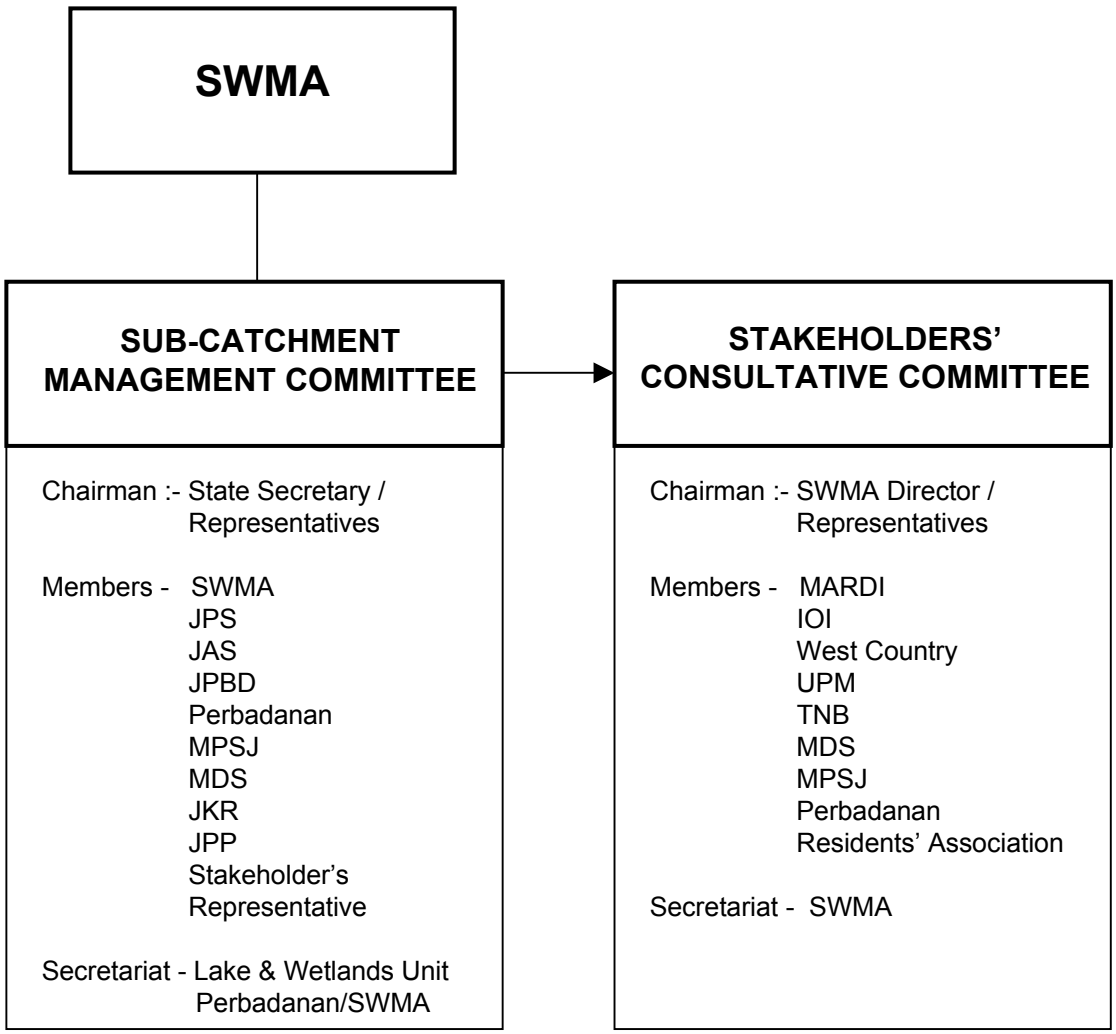
Secretariat: SWMA/Perbadanan Putrajaya's Lake and Wetlands Unit

Since the Committee is a sub-committee of the SWMA Technical Committee, chaired by the State Secretary, it is recommended that the Chairman of the Committee should be the State Secretary or his representative.

(c) Recommended functions of the Committee

The Perbadanan has the greatest stake in preserving the water quality in the Lake and has all the necessary resources to manage the Putrajaya Area to meet the desired water quality objectives of the Lake. Thus, it is recommended that the functions of the Committee be confined to the following main issues related to integrated management of the catchment*, for the areas outside Putrajaya*.

FIGURE 11: PROPOSED STRUCTURE FOR PUTRAJAYA LAKE CATCHMENT MANAGEMENT



- Provide advise relating to land use planning and management in the areas, that are necessary for integrated management of the catchment;
- Provide advise relating to drainage control and management;
- Provide advise relating to pollution control and management;
- Provide advise on the monitoring programme required for the integrated management of the catchment;
- Provide advise on the enforcement action required to be taken; and
- Provide advise on the works required to support the integrated management of the catchment.

A draft TOR for the Committee has been drawn-up (*see Appendix 2*). The Committee has to be formalised by the SWMA eventually.

With the above institutional arrangements the micro-management of the catchment areas within Putrajaya will be the responsibility of the Perbadanan, whereas those outside will be the responsibility of the SWMA. *However, from the macro-management perspective of the Langat River Basin, the Perbadanan still has to meet the water quantity and quality requirement, downstream of the Putrajaya Lake catchment, set by the SWMA*.

(d) Monitoring Functions to be delegated to Perbadanan

The SWMAE allows the SWMA to work with and also delegate its catchment management functions to any existing authority that has been carrying out such functions in the designated area before its designation.

Since the Perbadanan has developed a number of pertinent guidelines (Environmental Management Guide, Lake Management Guide, Stormwater Design Guidelines) that are important for the management of the catchment for 70% of the catchment area and is already carrying out the monitoring for the Lake, it is logical for the SWMA to delegate the monitoring functions of the Lake to the Perbadanan.

Also, the SWMA can adopt the pertinent Guidelines and make it legally applicable for the developments in the areas outside Putrajaya.

(e) Formation of Stakeholder's Consultative Committee

The SWMAE also allows the SWMA to create Catchment Stakeholders Committee to encourage catchment community participation in catchment management. Thus, it is recommended that a Stakeholder's Consultative Committee be formed, comprising representatives from the major stakeholders in the catchment and from Residents' Association. A draft TOR for the Committee has been drawn-up (*see Appendix 3*).

2.11 MONITORING AND REVIEW

The following items necessary to facilitate the monitoring and review exercise on the effectiveness of the implementation of the Plan are recommended:

- Setting-up a hydrological monitoring network
- Setting-up a water quality monitoring network
- Implementing the low-level ICMS

2.11.1 Hydrological Monitoring Network

The hydrologist has proposed that a hydrological monitoring station network be installed to support the management of the Putrajaya Lake, upon the implementation of the Lake Catchment Management Plan. A total of 5 rainfall measuring stations, 7 streamflow gauging stations, 5 water level and 6 groundwater level measuring stations have been proposed.

2.11.2 Water Quality Monitoring Network

2.11.2.1 The water quality specialist has proposed that a *Water Quality Monitoring Program* be implemented, over a 3-year period, upon the implementation of the Lake Catchment Management Plan.

2.11.2.2 The details of the Program are given in the *Putrajaya Lake Management Guide.* A total of 81 water level recorders and 23 water gauging stations have been proposed to be installed over the 3-year period.

2.11.3 Implementation of the low-level ICMS

2.11.3.1 To support the management of the large amount of monitoring data collected, such as hydrological data, water quality data, information on the health of the flora and fauna in the wetlands, etc., a *low-level Integrated Catchment Management System (ICMS)* has been developed as part of this study.

2.11.3.2 The Perbadanan Putrajaya is recommended to install and use the low-level ICMS on a stand-alone computer for a period of 6 months before making a decision on further development and refinement of the low-level ICMS.

3.0 CATCHMENT MANAGEMENT SYSTEM

To facilitate the implementation of the Plan there is a need for a Catchment Management System. The Consultant has proposed the following 10 elements as the basis for the System:

1. Catchment Management Policy
2. Catchment Management Issues
3. Legal and Other Requirements
4. Catchment Management Objectives and Targets
5. Catchment Management Programs
6. Catchment Management Institutional Structure
7. Catchment Community/Stakeholder Participation
8. Awareness and Training Requirements
9. Emergency Preparedness and Response
10. Monitoring and Review

4.0 IMPLEMENTATION SCHEDULE, BUDGET AND FUNDING

4.1 IMPLEMENTATION SCHEDULE AND BUDGET

4.1.1 Table 3 gives the indicative implementation schedule and budget for the various programs recommended by the respective specialists for an implementation period of 3 years.

4.1.2 From Table 3 it can be seen that the total indicative 3-year total cost of the recommended programs is about *RM 26.6 million*, made up of about *RM20.3 million for capital expenditure* and about *RM6.3 million for O&M expenditure*.

4.1.3 The bulk of the capital expenditure, about 83% is for *drainage improvement which cost about RM16.9 million*. Also, the bulk of the O&M expenditure, about 81%, comes from the water quality sampling costs over the 3-year period.

4.1.4 The following programs are recommended to be implemented in the first year upon approval of the Lake Catchment Management Plan:

- Water quality monitoring network
- Hydrological monitoring network
- Sewerage effluent discharge monitoring
- Sewerage improvement at UPM
- ICMS Installation
- Institutional Strengthening (additional manpower for MDS)

4.1.5 The total indicative capital expenditure in the first year is about *RM2,330,500* and that for O&M expenditure is about *RM1,100,500*.

4.1.6 74.5% of the capital expenditure in the first year, i.e. RM1,735,000 has been estimated for the upgrading of the sewerage treatment facilities (RM854,000) for the two student hostels in UPM and MARDI, and for the hydrological monitoring network (RM881,000). 69% of the O&M expenditure in the first year, i.e. RM725,000, is for the cost of the water quality sampling.

PUTRAJAYA LAKE CATCHMENT DEVELOPMENT AND MANAGEMENT PLAN

TABLE 3 IMPLEMENTATION SCHEDULE AND INDICATIVE BUDGET

	CAPITAL COSTS (RM)					O & M COSTS (RM)					REMARKS
PROGRAMS	**Year 1**	**Year 2**	**Year 3**	**Unscheduled**	**Total**	**Year 1**	**Year 2**	**Year 3**	**Unscheduled**	**Total**	
1. Water Quality Monitoring Network	335,000	425,000	335,000		**1,095,000**	725,000	1,815,000	2,446,400		**4,986,400**	O & M Cost includes
(Refer App. 9.1 for details)											sampling costs
2. Development of groundwater well field				144,000	**144,000**				16,433	**16,433**	To be implemented
(Refer App. 9.2 for details)											when needed
3. Hydrological Monitoring Network	881,000	0	0	881,000	**881,000**	69,000	69,000	69,000		**207,000**	
(Refer App. 9.3 for details)											
4. Drainage Improvement Cost											To be implemented
(a) MARDI				8,942,400	8,942,400				56,000	56,000	as part of each
(b) UPM				7,776,000	7,776,000				60,000	60,000	stakeholder's
(c) IOI				72,000	72,000				14,400	14,400	development program
(d) West Country				31,500	31,500				6,300	6,300	
(e) Cyberjaya				81,000	81,000				16,200	16,200	
(Refer App. 9.4 for details)					**16,902,900**					**152,900**	
5. Sewerage Improvement/Monitoring Cost											
(a) UPM	854,000				854,000	55,800	55,800	55,800		167,400	
(b) MARDI	240,000				240,000	37,200	37,200	37,200		111,600	
(c) IOI	0				0	9,300	9,300	9,300		27,900	
(d) Cyberjaya	0				0	37,200	37,200	37,200		111,600	
(Refer App. 9.5 for details)					**1,094,000**	139,500	139,500	139,500		**418,500**	
6. ICMS Installation and Improvement	20,500	200,000			**220,500**						
(Refer App. 9.6 for details)											
7. Institutional Strengthening (manpower)						167,000	167,000	167,000		**501,000**	
(Refer App. 9.7 for details)											
TOTAL COSTS	**2,330,500**	**625,000**	**335,000**	**17,927,900**	**20,337,400**	**1,100,500**	**2,190,500**	**2,821,900**	**169,333**	**6,282,233**	

4.2 FUNDING

4.2.1 Funding Sources

4.2.1.1 The three main sources of funding for the successful implementation of the Consultant's recommendations are:

- The Federal Government
- The Selangor State Government
- The individual stakeholders

4.2.1.2 The Federal Government, through Perbadanan Putrajaya as the main stakeholder in the catchment, will have to bear most of the cost associated with the implementation of the recommended programs within the 70% of the catchment where Putrajaya lies.

4.2.1.3 The Selangor State Government, through its respective agencies and local authorities, will have to bear additional costs arising from increased regulatory supervision and maintenance in the 30% of the Lake catchment area that lies within the State, to meet the desired environmental objectives for the catchment.

4.2.1.4 The individual stakeholders in the catchment will have to bear additional costs as a result of complying with the additional regulatory requirements imposed in the catchment to meet the desired environmental objectives for the catchment.

4.2.2 Funding Principles

4.2.2.1 The Federal Government, as the main project proponent for the development of Putrajaya, and the primary beneficiary from the development will most probably have to bear all the additional costs arising from the implementation of the recommended programs in the Lake Catchment Management Plan, that would not normally have been expended by the Selangor State Government and the individual stakeholders under normal circumstances.

4.2.2.2 However, the Selangor State Government and the individual stakeholders also benefit from the development of Putrajaya, through increased economic activities and appreciation of property values due to their proximity to Putrajaya and its high quality living environment. Thus, it is not unfair to expect the Selangor State

Government and the individual stakeholders in the catchment to bear part of the additional costs arising from the implementation of the recommended programs and compliance with the high regulatory requirements set to meet the desired environmental objectives for the Putrajaya Lake and its catchment.

4.2.2.3 An equitable approach has to be found through negotiations between the Federal and State Government of Selangor. As for the individual stakeholders in the catchment the following approach maybe acceptable:

(a) For *existing and committed developments* in the catchment it would be fair to compensate the respective affected stakeholders for the additional costs burden incurred by them as a result of complying with the requirements of the programs in the Lake Catchment Management Plan. Actual % compensation will have to be negotiated.

(b) For all uncommitted developments the additional cost associated with complying with the requirements of the programs in the Lake Catchment Management Plan shall be borne by the respective stakeholders, as part of compliance with the regulatory requirements. *The regulatory provisions for the management of the development in the Lake catchment will be further strengthened by the designation of the Putrajaya Lake Catchment as a designated sub-catchment under the SWMA Enactment, as recommended by the Consultant.*

4.2.3 Funding For The Recommended Programs

4.2.3.1 Based upon the above funding principles the Consultant has identified the possible funding sources for the recommended programs. They are given in Table 4 and are discussed below.

4.2.3.2 Water Quality Monitoring Network

The Perbadanan Putrajaya is the primary stakeholder of Putrajaya Lake and is also the body responsible for the monitoring of the water quality in the Lake. Thus, the most likely funding source for this program is the Perbadanan Putrajaya.

TABLE 4 POSSIBLE FUNDING SOURCES

FUNDING SOURCE	PROGRAMS	CAPITAL COSTS (RM)	O & M COSTS (RM)	REMARKS
Perbadanan Putrajaya	1. Water Quality Monitoring Network	1,095,000	4,986,400	To be implemented in Year 1 over a 3-year period
	2. Development of groundwater well field	144,000	16,433	To be implemented when needed
	3. Hydrological Monitoring Network	881,000	207,000	To be implemented in Year 1
	4. Sewerage Effluent Monitoring		418,500	To be implemented in Year 1 over a 3-year period
	5. ICMS Installation	20,500		To be implemented in Year 1 for a trial period of 6 months
	6. ICMS Improvement	200,000		To be decided based on 6 months trial
TOTAL COST TO BE BORNED BY PERBADANAN PUTRAJAYA		**2,340,500**	**5,628,333**	
Federal Government	1. Sewerage Improvement Cost	1,094,000		Sewerage Improvement in UPM and MARDI to be implemented in Year 1 (subject to negotiation with UPM and MARDI)
	2. Institutional Strengthening		167,000	1. Annual O & M cost 2. To be implemented in Year 1 3. Subject to negotiation with the Selangor State Government
	3. Drainage Maintenance Cost		152,900	Federal Government to fund maintenance program in areas outside Putrajaya
TOTAL COST TO BE BORNED BY FEDERAL GOVERNMENT		**1,094,000**	**319,900**	
Selangor State Government	Institutional Strengthening		167,000	1. Annual O & M cost 2. To be implemented in Year 1 3. Subject to negotiation with the Federal Government
TOTAL COST TO BE BORNED BY SELANGOR STATE GOVERNMENT			**120,000**	
MARDI	1. Drainage Improvement Cost	8,942,400		To be implemented as part of MARDI's development program
	2. Sewerage Improvement Cost	240,000		Subject to negotiation with Federal Government (to be implemented in Year 1)
TOTAL COST TO BE BORNED BY MARDI		**9,182,400**		
IOI	Drainage Improvement Cost	**72,000**		
TOTAL COST TO BE BORNED BY IOI		**72,000**		
West Country	Drainage Improvement Cost	**31,500**		To be implemented as part of each stakeholder's development program
TOTAL COST TO BE BORNED BY WEST COUNTRY		**31,500**		
Cyberjaya	Drainage Improvement Cost	**81,000**		
TOTAL COST TO BE BORNED BY CYBERJAYA		**81,000**		
SKVE	Drainage Improvement Cost**			
TOTAL COST TO BE BORNED BY SKVE PROJECT		**		To carry out drainage improvement in UPM and MARDI areas which are affected by the respective project ** Costs cannot be ascertained
ERL	Drainage Improvement Cost**			
TOTAL COST TO BE BORNED BY ERL PROJECT		**		
UPM	1. Drainage Improvement Cost	7,776,000		To be implemented as part of UPM's development program
	2. Sewerage Improvement Cost	854,000		Subject to negotiation with Federal Government (to be implemented in Year 1)
TOTAL COST TO BE BORNED BY UPM		**8,630,000**		

4.2.3.3 Development of groundwater well field

The groundwater well field can be developed by the Perbadanan Putrajaya if required to meet the irrigation and other water needs in Putrajaya. Thus, the funding source for this program will be the Perbadanan Putrajaya.

4.2.3.4 Hydrological Monitoring Network

Similar to the water quality monitoring network the hydrological monitoring network is an essential requirement for the management of the Putrajaya Lake. Thus, the most likely funding source for this program is the Perbadanan Putrajaya.

4.2.3.5 Drainage Improvement Program

(1) There is no immediate need for the improvement of the existing drainage systems outside Putrajaya. All of the recommended drainage improvements for the following stakeholders are to be implemented by the respective stakeholders, as part of their normal development cost:

- MARDI
- UPM
- IOI
- West Country
- Cyberjaya
- ERL and SKVE project proponents

(2) There is a need to ensure that the respective project proponents for the SKVE and ERL implement the recommended vegetated landscape drainage buffer in the MARDI and UPM areas, where the SKVE and ERL passes through. There is also a need to ensure that the drainage inlets from the SKVE and ERL to the vegetated landscape drainage corridor are provided with GPTs. The costs for complying with the recommended requirements will most probably be the responsibility of the respective project proponents.

(3) The responsibility for the maintenance of the drainage corridors and mini-wetlands in the public areas lies with the pertinent local authorities, whereas those in the individual stakeholder's areas, such as MARDI, UPM and IOI, should be borne by the respective stakeholders. Since the maintenance funds of local authorities are

limited the Federal Government may have to develop and fund specific maintenance programs for identified areas outside Putrajaya.

4.2.3.6 Sewerage Improvement/Monitoring Program

(1) There is an immediate need to upgrade the sewage treatment facilities of two student hostels in UPM. IWK has identified the MARDI and UPM areas as part of the sewerage catchment area to be served by its proposed Kota Perdana/Listari central sewerage treament plant. However, the exact date of the implementation of the central sewerage treatment plant is not certain. Thus, in the interim there may be a need to upgrade the sewage treatment facilities of the two student hostels in UPM by constructing the recommended UPM-MARDI central sewage treatment plant. The cost for the upgrading will most probably have to be borne by both the Federal Government and UPM.

(2) There is a need to conduct additional monitoring of the quality of the sewage effluent discharge coming from the UPM, MARDI, IOI and Cyberjaya, beyond those required by the DOE. The monitoring can be carried out as an additional part of the water quality monitoring program. The cost for this monitoring program will have to be borne by the Perbadanan Putrajaya.

4.2.3.7 ICMS Installation and Improvement Program

(1) There is an immediate need to purchase the ArcView GIS software and a personal computer for the installation and training in the use of the low-level ICMS, developed as part of this study. The cost for the purchase has to be borne by the Perbadanan Putrajaya. The SWMA may also wish to make the same purchase, and send its staff for the training in the use of the low-level ICMS.

(2) After a recommended trial period of 6 months, the Perbadanan Putrajaya may be able to make a decision on whether to proceed with further improvement of the ICMS. The next-stage improvement cost for the low-level ICMS will also have to be borne by the Perbadanan Putrajaya.

4.2.3.8 Institutional Strengthening Program (Additional Manpower for MDS)

There is an immediate need to strengthen the existing institutional structure in the Majlis Daerah Sepang to cope with the additional recommended regulatory responsibilities for developments in the areas outside Putrajaya. The costs associated with this program will have to be borne by both the Federal and Selangor State Government.

4.3 COST RECOVERY

4.3.1 The capital expenditure associated with the programs to achieve the environmental objectives and desired living environment for the Lake catchment is not expected to be recovered. However, there is a need for the respective Local, State and Federal authorities to consider the option of implementing a means of cost recovery for the *funding of the maintenance programs* in the Lake catchment area.

4.3.2 A detailed review of the various possible funding options has to be carried out, which is beyond the scope of the current study. The following are two possible equitable policy options for cost recovery:

- Adopt and implement the policy of *"the polluter pays"*
- Adopt and implement the policy of "*the direct beneficiaries pays"*

4.3.3 The *"polluter pays"* policy option will require the respective regulatory authorities to diligently enforce all pertinent legislative provisions for the imposition of fines and penalties for causing pollution in the catchment. This would help to encourage regulatory compliance, in addition to being a source of funds for the maintenance programs. The SWMA Enactment provides for quite drastic fines and penalties for causing pollution in a designated catchment.

4.3.4 The *"direct beneficiary pays"* policy option will require the respective regulatory authorities to find ways to collect funds from direct beneficiaries of the enhanced living environment in the Lake catchment. One such way is to put a surcharge on the assessment rates of the property owners in the Lake catchment areas.

APPENDIX 1
COMPARISON OF VARIOUS STANDARDS

ITEM	PARAMETER (mg/l Unless Otherwise Stated)	LIMITING VALUE			
		RECOMMENDED EFFLUENT STANDARD FOR PUTRAJAYA LAKE CATCHMENT	DOE'S STANDARD A	PUTRAJAYA LAKE AMBIENT WATER QUALITY STANDARD	INTERIM NATIONAL RIVER WATER QUALITY STANDARD MALAYSIA - CLASS IIB
1.	Temperature (°C)	40	40	Normal ± 2	
2.	pH (units)	6.0 - 9.0	6.0 - 9.0	6.5 - 9.0	6.0 - 9.0
3.	BOD_5 at 20°C	20	20	3	3
4.	COD	50	50	25	25
5.	Suspended Solids	50	50	50	50
6.	Mercury	0.005	0.05	0.0001	0.001
7.	Cadmium	0.01	0.01	0.002	0.01
8.	Chromium, hexavalent	0.05	0.05	0.005	0.05
9.	Arsenic	0.05	0.05	0.05	0.05
10.	Cyanide	0.05	0,.05	0.02	0.02
11.	Lead	0.10	0.10	0.05	0.05
12.	Chromium, trivalent	0.20	0.20	-	-
13.	Copper	0.20	0.20	0.02	0.02
14.	Manganese	0.20	0.20	0.10	0.1
15.	Nickel	0.20	0.20	0.02	0.05
16.	Tin	0.20	0.20		-
17.	Zinc	1.0	1.0		5.0

ITEM	PARAMETER (mg/l Unless Otherwise Stated)	LIMITING VALUE			
		RECOMMENDED EFFLUENT STANDARD FOR PUTRAJAYA LAKE CATCHMENT	DOE'S STANDARD A	PUTRAJAYA LAKE AMBIENT WATER QUALITY STANDARD	INTERIM NATIONAL RIVER WATER QUALITY STANDARD MALAYSIA - CLASS IIB
18.	Boron	1.0	1.0	1.0	1.0
19.	Iron	1.0	1.0	1.0	1.0
20.	Phenol	0.001	0.001		10
21.	Free Chlorine	0.5	1.0	1.5	-
22.	Sulphide	0.5	0.5		
23.	Oil and Grease	Not Detectable	Not Detectable	1.5	
24.	Dissolved Oxygen	5.0		5.0 - 7.0	5.0 - 7.0
25.	Total Phosphorous	2.0		0.05	0.2
26.	Total Nitrogen	10.0			
27.	Nitrate (NO_3 - N)	-		7.0	7.0
28.	Nitrite (NO_2 - N)	-		0.04	0.4
29.	E-Coli (Counts/100 ml)	400		100	400
30.	Total Coliform (Counts/100 ml)	5,000		5,000	5,000
31.	Salmonella (Counts/l)			0	
32.	Enteroviruses (PFU/l)			0	
33.	Chlorophyll a (ug/l)			0.7	
34.	Floatables			Not Visible	Not Visible
35.	Colour (TUC)			150	150
36.	Conductivity (ms/cm)			1,000	1000

ITEM	PARAMETER (mg/l Unless Otherwise Stated)	LIMITING VALUE			
		RECOMMENDED EFFLUENT STANDARD FOR PUTRAJAYA LAKE CATCHMENT	DOE'S STANDARD A	PUTRAJAYA LAKE AMBIENT WATER QUALITY STANDARD	INTERIM NATIONAL RIVER WATER QUALITY STANDARD MALAYSIA - CLASS IIB
37.	Salinity (ppt)			1.0	1.0
38.	Turbidity (NTU)			50	50
39.	Transparency (Secchi)			0.6	
40.	Hardness			250	250
41.	Taste			No Objectional	No Objectional
42.	Odour			No Objectional	No Objectional
43.	Aluminium			<0.05 if pH < 6.5 <0.01 if pH > 6.5	-
44.	Ammoniacal Nitrogen			0.3	0.3
45.	Ammonia			0.02 - 0.03	
46.	Antimony			0.03	
47.	Barium			1.0	1.0
48.	Beryllium			0.004	
49.	Flourine			1.5	1.5
50.	Silica			50	50
51.	Selenium			0.01	0.01
52.	Silver			0.05	0.05
53.	Sulphur			0.05	0.05
54.	Sulphate			250	250
55	Gross-alpha (Bq/l)			0.1	0.1

ITEM	PARAMETER (mg/l Unless Otherwise Stated)	LIMITING VALUE			
		RECOMMENDED EFFLUENT STANDARD FOR PUTRAJAYA LAKE CATCHMENT	DOE'S STANDARD A	PUTRAJAYA LAKE AMBIENT WATER QUALITY STANDARD	INTERIM NATIONAL RIVER WATER QUALITY STANDARD MALAYSIA - CLASS IIB
56.	Gross-Beta (Bq/l)			1.0	1.0
57.	Radium-226 (Bq/l)			<0.1	<0.1
58.	Strontium-90 (Bq/l)			<1.0	<1
59.	Carbon Chloroform Extract (ug/l)			500	500
60.	MBAS/BAS (ug/l)			500	500
61.	Oil & Grease (mineral) (ug/l)			40, NF	40 ; NF
62.	Oil & Grease (emulsified edible) (ug/l)			700, NF	7,000 ; NF
63.	PCB (ug/l)			0.1	0.1
64.	Aldrin/Dieldrin (ug/l)			0.02	0.02
65.	BHC (ug/l)			2.0	2.0
66.	Chlordane (ug/l)			0.08	0.08
67.	t-DDT (ug/l)			0.1	0.1
68.	Endosulfan (ug/l)			10	10
69.	Heptachlor/Epoxide (ug/l)			0.05	0.05
70.	Lindane (ug/l)			2.0	2.0
71.	2,4-D (ug/l)			70	70
72.	2,4,5-T (ug/l)			10	10
73.	2,4,5-TP (ug/l)			4.0	4.0
74.	Paraquat (ug/l)			10	10

APPENDIX 2

TERMS OF REFERENCE FOR SUB-CATCHMENT MANAGEMENT COMMITTEE

The following is the suggested Terms of Reference for the Sub-Catchment Management Committee:

1. To review land use and development plans in the catchment areas outside Putrajaya and to advise the Selangor Waters Management Authority (SWMA), and such other local and state authorities or agencies, on acceptable land use or development for the areas, so as to support the integrated management of the Lake catchment.

2. To advise the SWMA and such other local and state authorities on acceptable land use for the structure and local plans that are to be prepared for the areas;

3. To review and assess water quality trends in the streams, wetlands and the Lake and to make recommendations for pollution control and enforcement action in the areas, where this is necessary to protect the water quality;

4. To review the monitoring programme and make recommendations for changes in the areas, where they are required to enhance catchment management;

5. To review and advise on acceptable physical and engineering works in the areas, which are necessary for water quality management and catchment protection; and

6. To advise on stakeholders' participation in catchment management and to refer matters that affect stakeholders to the Stakeholders' Group for review and feedback.

APPENDIX 3

TERMS OF REFERENCE FOR STAKEHOLDERS' GROUP

The following are the suggested Terms of Reference for the Stakeholders' Group (SG):

1. To review matters related to management of the Putrajaya Lake Catchment that is referred to the SG by the Sub-Catchment Management Committee (SCMC);

2. To provide feedback or decisions to the SCMC on matters referred to it where this requires a decision of members of the SG; and

3. To consult, where necessary, with members of the public, land owners or residents' association and such other individuals or groups on matters (referred by the SCMC) related to management of the Putrajaya Lake Catchment that are likely to affect them.

CHAPTER 1
INTRODUCTION

1.0 INTRODUCTION

1.1 THE FEDERAL GOVERNMENT ADMINISTRATIVE CENTRE

1.1.1 Putrajaya (see Figure 1.1) is being developed by the Federal Government to be the new Federal Government Administrative Centre. It will house the Federal Government ministries, departments and agencies and will provide for a more efficient management and operation of the Federal Government.

Fig. 1.1 Putrajaya – The Federal Government Administrative Centre

1.1.2 Its area of 4290 hectares (10,600 acres) was created through an Agreement between the Federal Government and the State Government of Selangor, in which the area lies. The Agreement essentially gives the Federal Government the powers of local government and land administration for the Putrajaya Area. The Minister responsible for the Area is the Prime Minister.

1.1.3 To administer and manage the Putrajaya Area, the Federal Government has established a body corporate known as the *Perbadanan Putrajaya* or in brief, Perbadanan in this Report. The Perbadanan has been assigned all the powers of local government and land administration for the Putrajaya Area.

See Vol.2 - Section 8.1.3 The Status of Perbadanan Putrajaya

1.1.4 The masterplan of Putrajaya emphasises the development of a "City in a Garden", with generous open spaces and parks, and a 552-hectare man-made lake, the *Putrajaya Lake,* as its principal landscape feature and focal point.

1.2 THE PUTRAJAYA LAKE

1.2.1 The Putrajaya Lake is required to cater to multi-functional uses and has to be in pristine condition always, with a high water quality. It will be used for recreation, boating, fishing and water transport, in addition to enhancing the aesthetics of the Putrajaya landscape.

1.2.2 The Lake will be created in two Phases, through the building of a temporary dam (Phase-1) and a main dam (Phase-2) across the Sg. Chuau (see Figure 1.2). The Phase-1 Lake has already been created and the Phase-2 main dam is under construction. Also, to enhance the water quality in the Lake six artificial wetlands have been created to improve the quality of the runoffs flowing into the Lake.

1.2.3 The total catchment area of the Lake is 6066 hectares (14,982 acres), of which 1774 hectares (4382 acres) lies outside the Putrajaya. Also, most of the Lake catchment areas outside of the Putrajaya are located in the upstream part of the catchment.

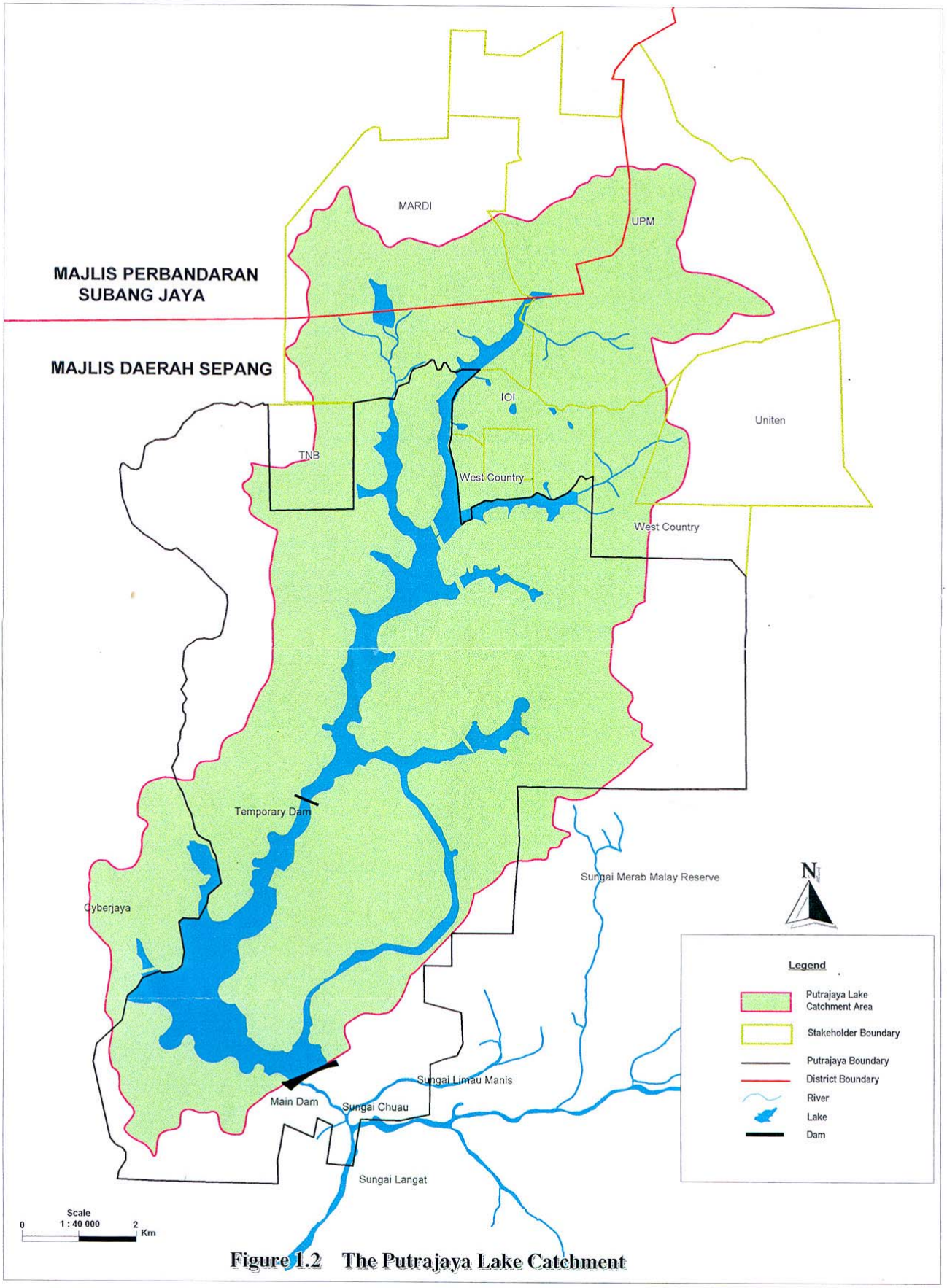


Figure 1.2 The Putrajaya Lake Catchment

1.3 THE CATCHMENT MANAGEMENT AND DEVELOPMENT PLAN

1.3.1 The Federal Government is concerned about the land developments and human activities in the Lake catchment areas outside of the Putrajaya. The six artificial wetlands were designed to improve and not treat the runoffs flowing into the Lake from the upstream areas. The uncoordinated land development and human activities in the outside areas will have significant negative impacts on the high water quality desired for the Lake.

1.3.2 To address its concern on the coordination and management of the land development and human activities in the catchment areas outside of Putrajaya the Federal Government has formed the *Putrajaya Lake Catchment Management Committee (PLCMC)* in January 1997. The PLCMC is an administrative committee comprising of representatives from various government agencies and departments, including those from the 3 local authorities (Putrajaya, Sepang and Subang Jaya) and two major land stakeholders (UPM and MARDI) in the catchment. The Chairman of the PLCMC is the Secretary-General of the Ministry of Agriculture.

See Vol.2 - Section 8.2.2.7 Putrajaya Lake Catchment Management Committee

1.3.3 The PLCMC recognises that to achieve and maintain the high water quality objective set for the Putrajaya Lake there is a need to prepare and implement a comprehensive *Catchment Management and Development Plan (CMDP)* for the Putrajaya Lake.

1.4 THE CONSULTANT

1.4.1 In view of the importance of attaining and maintaining the high water quality objective for the Putrajaya Lake the Federal Government, through the Perbadanan, has engaged a Consultant to prepare the CMDP for the Lake.

1.4.2 The Consultant's study approach and study scope is given in Chapter 1 and Appendix 1-1, respectively, in Volume 2 of this Report.

1.4.3 The Consultant's Study Team members and their respective contributions to the study are given in Appendix 1.

CHAPTER 2
THE CURRENT SITUATION

2.0 THE CURRENT SITUATION

2.1 INTRODUCTION

2.1.1 It is recognised that the only way to achieve the high water quality objective for the Putrajaya Lake is to adopt an Integrated Catchment Management (ICM) approach for the Putrajaya Lake catchment.

2.1.2 The ICM approach can be defined as:

"The co-ordinated management of the resources existing in the natural environment, comprising of air, water, land, flora and fauna, based on the river basin as a geographical unit, with the objective of balancing the needs of man to utilise the resources for the improvement of his living conditions with the necessity of conserving the resources to ensure their sustainable use."

2.1.3 Ideally, the implementation of the above integrated management approach for a catchment should be by a single catchment management body. However, in reality the existing institutions governing the land development and human activities in a catchment are usually not organised according to the river basin as a geographical unit.

2.1.4 The above implies that, in the absence of a single body to implement such an approach for a catchment, there is a need to ensure proper co-ordination between all pertinent institutions having planning, approval, monitoring and enforcement jurisdiction over all land development and human activities in the catchment. This is the case for the Putrajaya Lake catchment.

2.1.5 The following management issues have been identified to be important for the development and implementation of an ICM Plan for the Putrajaya Lake catchment:

1. Pollutant-carrying capacity of the Lake
2. Effectiveness of the Wetlands
3. Point and non-point pollutants sources management
4. Water quantity management

5. Land-use planning
6. Drainage planning
7. Sewerage planning
8. Planning and land-use control
9. Drainage management and control
10. Environmental management and pollution control
11. Co-ordination between regulatory agencies
12. Monitoring and review

2.2 THE MANAGEMENT ISSUES

2.2.1 Pollutant-carrying capacity of the Lake

2.2.1.1 The pollutant assimilation capacity of the Putrajaya Lake system (see Figure 2.1) for the existing and future land-use in the catchment is an important factor affecting the ambient water quality. A Putrajaya Lake Water Quality Standard (see Appendix 2) has been adopted and the achievement of this objective will affect land use and activities management. Thus, a water quality modelling study was carried out to estimate the impact of current and future development on the Lake and Wetlands.

See Vol-2, Section 2.6.2 Water Quality Modelling

2.2.1.2 In a previous study, a 6-month water quality monitoring program to assess the pre-construction baseline water quality was carried out at nine water quality monitoring stations in Sg. Chuau, from December 1996 to May 1997. The following were the main results from the monitoring:

- There was high Total Phosphorus (mostly in the particulate form) in the waters flowing from the Upper North and Sg. Bisa sub-catchments. The concentration was lower from the Upper West sub-catchment.
- The Total Nitrogen from all sub-catchments exceeded the guidelines.
- The coliform counts from all sub-catchments also exceeded the guidelines.
- Several heavy metals also exceeded the guideline levels. The high Total Iron and Manganese concentration is not unusual but the high Total Mercury is of concern.
- Insecticide and herbicide concentrations were all low.

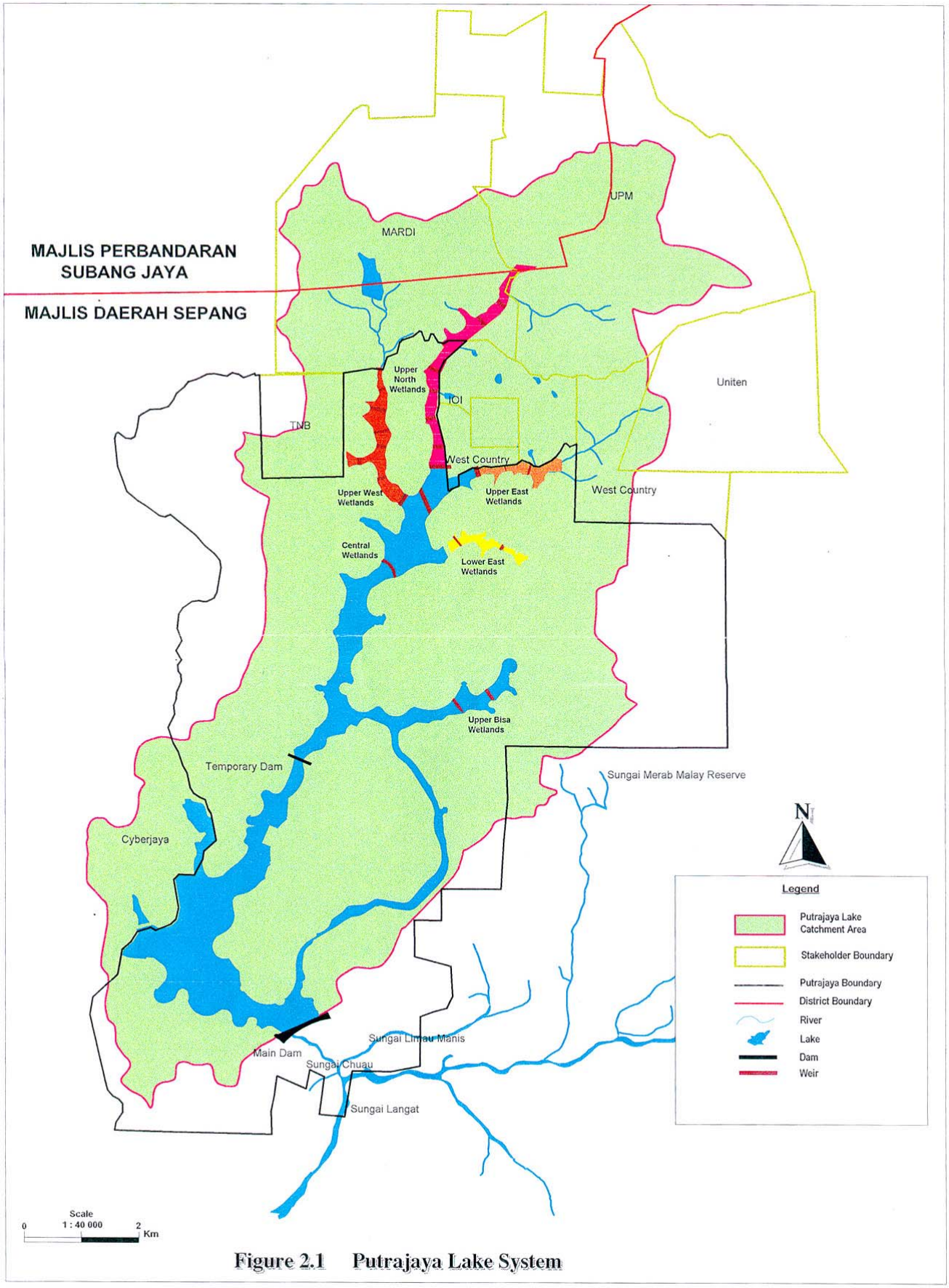


Figure 2.1 Putrajaya Lake System

2.2.1.3 The wetlands is still in the commissioning stage and water quality monitoring is being carried out, twice monthly since 1997, at the various wetland cells by Marimas, the water quality monitoring subcontractor of Putrajaya Holdings Sdn. Bhd. The following are some results based on the data for the month of April 1999.

- Nutrient input concentration from the catchments above the Wetlands is negligible.
- Coliform count exceeded the values in the proposed Putrajaya Ambient Lake Quality Standards.
- Based on the data, due to the low concentrations measured, no conclusions could be made on the efficiency of the wetlands in removing nutrient pollutants, especially phosphorus.

2.2.1.4 For the purpose of the water quality modelling carried out in this study, and due to the difference in the results obtained before and after wetland construction, selected water quality parameters were measured in the Lake and Wetlands over a period of two weeks by the UPM team. In addition sampling was carried out at certain streams in UPM and MARDI. The results from the monitoring are as follows:

- There was no consistent pattern of water quality improvement from the upstream to downstream wetland cells. Nutrient concentrations of phosphorus and nitrogen fluctuated irregularly along the cells and did not indicate removal.
- This irregular pattern could possibly be due to several reasons. One is the effect of re-suspension of sediments and the release of sediment-attached nutrient pollutants into the water column.
- If the wetland cells do improve water quality by reduction of nutrients, then the observed pattern of nutrient concentrations could be due to nutrient pollutant input from lateral inflows into the wetland cells.
- Along the grass-lined streams in UPM and MARDI, filterable Total Phosphorus reduced with distance downstream. TSS is also substantially reduced.

2.2.1.5 Table 2.1 shows the range of the water quality observed at the Temporary Dam by the UPM team.

Table 2.1 Observed Water Quality at the Temporary Dam

Parameter	Range (mg/l)
DO	2.8- 4.0
BOD	0.11- 1.89
NO3	0.5- 2.9
TP	0.04- 0.57
Turbidity, NTU	2.0- 26.68
Ecoli, count/100ml	0- 4000
Tcoli, count/100ml	0- 5000

2.2.1.6 Two previous water quality modelling studies have been carried out for the Putrajaya Lake system. They were by Perunding Kota Bistari (PKB) and Angkasa GHD Engineers (AGHD). PKB used a simple water quality model whereas AGHD used the slightly more sophisticated AQUALM model. The AGHD model only included the Wetlands and the Lake up to the Temporary Dam, that is Phase 1A Lake. The significant conclusions from both model studies are as follows:

- *PKB conclusion* - An inflow phosphorus concentration of 0.1 mg/l is the acceptable upper limit for the mean TP in the runoff flows from the catchment.

- *AGHD conclusion* – Under normal urban loadings of 0.4 mg/l Total Phosphorus, the target of 0.05 mg/l Total Phosphorus influent concentration into the Primary Lake is not achieved. The calculated influent concentration to achieve the target was 0.13 mg/l. AGHD concluded that the maximum permissible average concentration would likely be lower than 0.15 mg/l, possibly even 0.1 mg/l.

2.2.1.7 The water quality model used in this Study is the MIKE 11 water quality module, part of a professional hydraulic engineering simulation software package. The calibration runs of the model reproduced the results observed by the UPM team, i.e. there is no consistent degradation or removal of nutrients between the top and bottom end of each wetland cell system.

2.2.1.8 Two hydrological scenarios were simulated: 1) existing pollutant influent concentrations and estimated lateral inflow concentrations, and reduced phosphorus influent concentration and the same estimated lateral inflow concentrations for normal hydrological year; 2) two additional hydrological conditions were utilised, that is, wet and dry hydrological years. The results from the simulations are as follows:

Scenario 1 – comparison of current TP Pollutant loading from Top, with reduced, low TP loading from Top; same Lateral inflow loading.

Results
in wetlands: low P loading gave slightly better water quality
in Central Wetland: water quality almost same
in Lake: water quality almost same

Conclusion
The Lateral Inflows to the system are important in controlling P concentrations.

Scenario 2 - for dry (1.6 m) and wet (2.7 m) year, coincides with lower and higher pollutant loading respectively (constant low concentration).

Results
wet year gave slightly worse water quality
dry year gave very slightly better water quality

Conclusion
increased flow in wet year may short-circuit wetland processes

2.2.1.9 The main conclusions from the above discussions are:

- The baseline water quality data indicated that the concentration of Total Phosphorus, Total Nitrogen, Coliform and several heavy metals exceeded the desired water quality standard.

- The UPM team water quality monitoring results indicated that there is no consistent trend of water quality improvement from the upstream to downstream wetland cells. Also, it indicated that the grass-lined streams in UPM and MARDI are effective in reducing TSS and Total Phosphorus (of the reactive, dissolved component but not of the particulate component).

- The existing Total Phosphorus concentration of 0.7 mg/l in the influent waters at the upstream end of the wetlands will not be reduced substantially in the wetlands. This is because based on monitoring results, there change in the Phosphorus concentrations between the first and last cell of the individual wetlands varied inconsistently. Both increase and decrease in concentrations were recorded

- The differences in the observed and the AQUALM model removal efficiencies of 20-80% for the wetlands may be because the AQUALM model had assumed each whole wetland system as one single big cell and thus could not account for the lateral inflows into the various wetland cells.

- The lateral inflows into the wetland cells could be the major reason why there is no consistent trend of water quality improvement from the upstream to downstream wetland cells.

- The water quality modelling indicated that Nitrate and BOD removal is effective for all three hydrological scenarios - wet, normal and dry hydrological years, under the existing condition. However, phosphorus appears to be the factor that will affect the lake water quality.

2.2.2 Effectiveness of the Wetlands

2.2.2.1 The wetlands play a very important role in improving the water quality of the runoff flowing into the Putrajaya Lake. The wetland plants helps to trap sediments and the biological activity of the organisms associated with the plant helps to remove nutrients from the runoff.

2.2.2.2 A detailed inventory of the flora and fauna in the wetlands was carried out (see Vol-2, Section 2.7 Wetland Ecological Status). The following are the observations and recommendations arising from the inventory exercise:

1. Planting density seems to be too high in some wetland cells (see Figure 2.2). The recommended planting density is 12-14 stalks/sq.m (*Refer to Putrajaya Constructed Wetlands, Advisory Report #8, Wetland International – Asia Pacific*).

   Since there are no specific and definitive works on the `Optimum Planting Density' of various wetland plant species, studies are required to determine the `Optimum Planting Density' and the `Rate of N-P-K Uptake' by various wetland plant species. This will help to assist the wetland manager in the management of the wetland.

2. The current plant species such as *Phragmites* sp. in particular and *Scirpus* sp., *Lepironia* sp. and *Eleocharis* sp. in general are relatively less resistant to pest and parasitic infection. However, further studies need to be carried out to identify the list of resistant species for possible replacement of the weak and relatively less resistant species in the wetland cells.

Figure 2.2
Observation of the effect of overcrowding

3. Weed is a major problem in the non-inundated and poorly inundated wetland cells. It is recommended that the wetland cells be maintained regularly to control the growth of weeds. (see Figure 2.3)

Figure 2.3
Observation of weed invasion in the wetlands

4. Pest infestation seems to be well-managed.

5. Domination of the fish population by the Tilapia species was confirmed from frequent physical observation at the weirs in the wetlands. However, detail fish sampling studies are required for definitive confirmation prior to implementation of any physical measure to control them.

See Vol-2, Section 2.7.4 Recommendations for sustaining flora and fauna

2.2.3 Point and non-point pollutants sources

It is very important to identify all the possible sources of point and non-point pollutant sources in the catchment so that proper management measures can be taken to control or eliminate them. A detailed pollutant input sources study was carried out (see Vol-2, Section 2.4 Pollutant input sources). The results from the assessment of the pollutant sources are discussed below.

2.2.3.1 Point Pollutant Sources

(1) The following point sources arising from sewage effluent have been identified:

- Sewage effluent discharge from MARDI (wetlands)
- Sewage effluent discharge from UPM (wetlands)
- Sewage effluent discharge from IOI (wetlands)
- Sewage effluent discharge from Cyberjaya Flagship Zone (Phase 2 Lake)

(2) The point sources will be managed in the sewerage masterplan (see Vol-2, Chapter 5)

(3) A **potential point source** that may pose a threat to the water quality in the Lake, may arise from accidents associated with the oil tankers moving along the road passing through the wetlands. It is recommended that the pertinent authorities (JKR, Perbadanan) ensure that Emergency Response Plans and Procedures are prepared and implemented to handle such potential emergencies.

2.2.3.2 Non-point Pollutant Sources

The following are the non-point pollutant sources and the recommended management measures.

- Runoffs from the road passing through the wetlands
  The drainage system from the roads shall be integrated into the drainage masterplan.

- Runoffs from within Putrajaya area entering directly into the Lake.

It is recommended that the vegetated drainage corridors coupled with mini wetland flood detention pond drainage systems be used instead of the proposed concrete drain linked to Gross Pollutant and Sediment Traps (GPT) type drainage system.

- Fertiliser and pesticide inputs from MARDI, UPM, IOI and Cyberjaya Flagship Zone maybe a problem.
  BMP guidelines on the use of fertilisers and pesticides have been prepared and are recommended to be followed by the above stakeholders.

2.2.4 Water Quantity Management

2.2.4.1 The amount of water in the Lake will depend predominantly on the amount of runoff from the Sg. Chuau catchment. The lack of runoff entering into the Lake or significant losses of water from the Lake will result in the deterioration of the water quality in the Lake, through the increase of pollutant concentration in the Lake. Hence, it is critical that all possible runoff arising from the Lake catchment should enter into the Lake system.

2.2.4.2 Other than the emergence of infiltration water to streams which subsequently discharged into the Lake, the geological and hydrogeological setting of the Sungai Chuau catchment reveals no other natural contribution of water, such as the presence of artesian water from the subsurface.

See Vol-2, Section 3.3.4 Water quantity management issues

2.2.4.3 The geological and hydrogeological setting of the basin (see Fig. 2.4) presents three possible situations for water seepage losses. They are:

- Losses through the hard rock - Although the catchment is resting on top of an anticline and is criss-crossed by 3 sets of fracture lineaments, water loss through the bedrock is not expected to be large.

- Losses through the peat layers - There is no hydraulic conductivity between the peat layers in Cyberjaya and

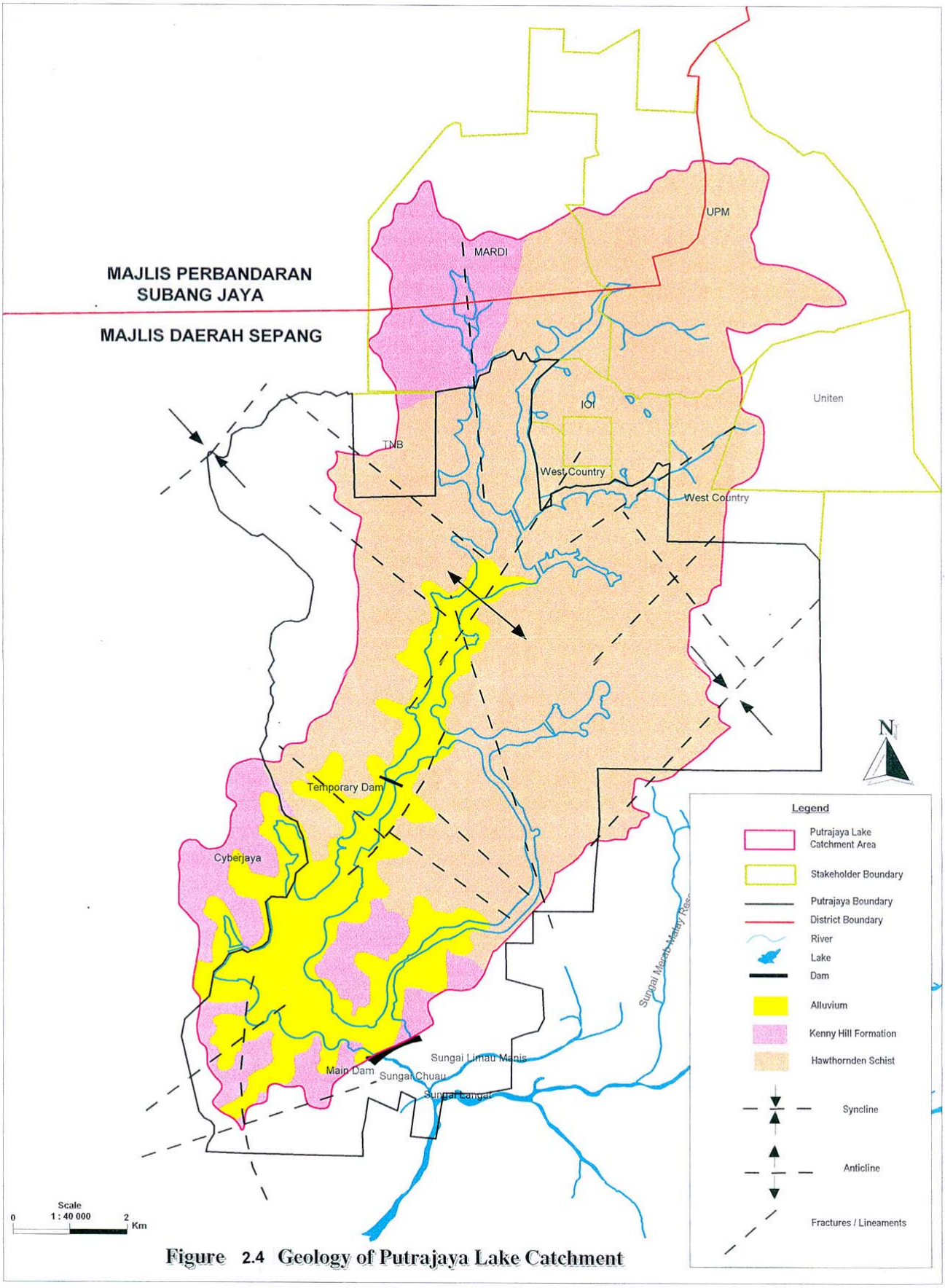


Figure 2.4 Geology of Putrajaya Lake Catchment

Putrajaya. Thus, no groundwater is expected to flow out of the catchment at the South-Eastern edge. Also, there is very little possibility for seepage under the Phase-2 dam as the Consultant for the dam has indicated in their report that all clay and peat layers will be removed during the construction of the dam.

- Losses through the Alluvium aquifer - Water loss through the Alluvium will not be significant.

See Vol-2, Section 3.3.4 Water quantity management issues

2.2.4.4 The compensation flow requirement at the main dam has been computed to be 0.186 m^3/s which is equal to 10% of the annual Average Flow. However, this value has to be verified with actual measured Annual Average Flow. Also, it has been computed that, for the average annual flow condition, the spill at the main dam ranges from 0.279 - 1.81 m^3/s. Thus, it was concluded that the duration for the filling-up of the dam will only be extended by a month (to 11 months) if compensation flow is provided for during the filling process, for the case of the 1:10 year dry minimum flow.

See Vol-2, Section 3.1.6 Compensation flow requirements from the main dam

2.2.4.5 Rainwater harvesting for domestic and other uses are consumptive in nature. Thus, they may have significant impact on the amount of water flowing into the Lake if they are practised widely in the catchment. However, a definite conclusion can only be made based on further detail hydrological studies and assessment of the volume of water that will be harvested.

See Vol-2, Section3.1.7 Rainwater harvesting and utilisation

2.2.4.6 A well field of 6 groundwater wells can be drilled, downstream of the main dam, to supply 0.5 m^3/s (10,000 g/hr) of groundwater to meet any water demand.

See Vol-2, Section3.3.4.1 Groundwater recharge to the Lake

2.2.4.7 The Perbadanan is planning to use the water in the Lake for the irrigation of the landscaped vegetation in the numerous parks within Putrajaya. There is a need to evaluate the impact on the water quality in the Lake due to the water

withdrawal from the Lake for irrigation purposes. *The situation is especially critical during a drought when irrigation demand is highest and there is no water inflow into the Lake.*

2.2.5 Land-use planning

2.2.5.1 The development in Putrajaya is controlled by the Putrajaya Masterplan. For the areas outside Putrajaya there is a need to ensure that the land-use, drainage and sewerage development are governed by similar master plans. The mechanism for this is through the Local Plan that is currently being prepared by the Jabatan Perancang Bandar dan Desa (JPBD) for the Multi-Media Super-Corridor area, excluding Cyberjaya and Putrajaya.

2.2.5.2 Figure 2.5 and Table 2.2 show the existing and committed land-use of the areas within the catchment, that is outside Putrajaya. The major land parcels in the catchment areas outside Putrajaya are:

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

FIGURE 2.5
EXISTING & COMMITTED
LANDUSE MASTERPLAN

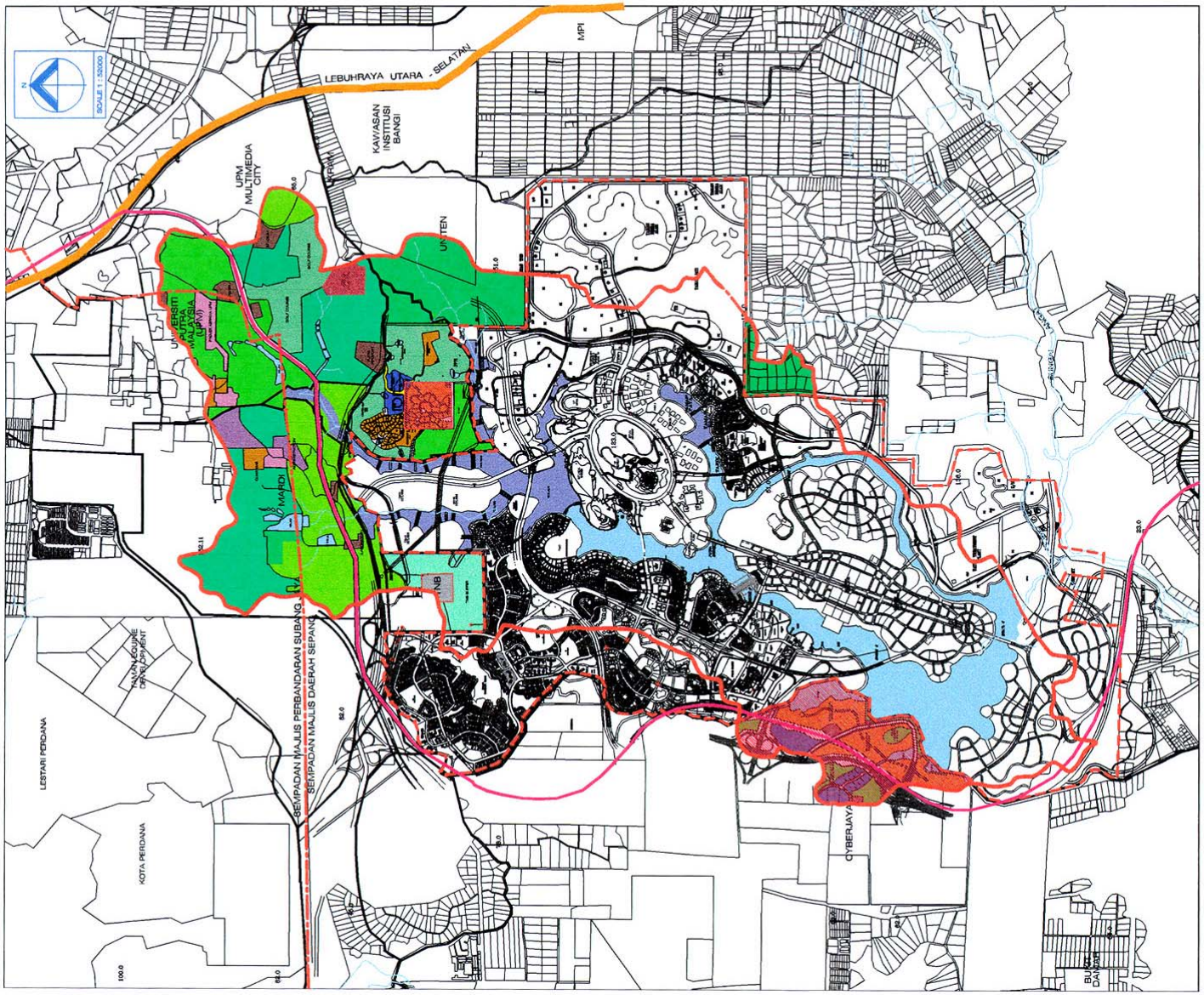


FIGURE :	TITLE : EXISTING & COMMITTED LANDUSE MASTERPLAN

CATCHMENT DEVELOPMENT AND MANAGEMENT PLAN FOR PUTRAJAYA LAKE

LEGEND :-

BUILDINGS	EXISTING ACRE	COMMITTED ACRE
HOUSING / QUARTERS	101.47	197.47
COMMERCIAL	17.46	12.15
HOSTELS/COLLEGE	59.76	-
TNB POWER STATION	28.95	-
ADMINISTRATION/OFFICE	71.12	66.45
ACADEMIC/R & D	-	-
FACILITIES	92.35	86.06
TOTAL	371.11	359.13
GREEN		
AGRICULTURE	543.33	-
GOLF COURSE	403.41	-
BUFFER ZONE	194.03	-
ORCHARDS	742.96	-
FARMS	723.98	-
OPEN SPACE/RECREATION	363.52	117.29
TOTAL	2970.23	117.29
WATER BODIES		
LAKE/POND	63.28	51.03
WETLAND	46.99	
TOTAL	110.27	51.03
OTHERS		
ROAD/DRAINAGE	242.85	-
EXPRESS RAIL LINK	-	157.95
PLUS HIGHWAY	-	313.81
OTHERS	34.48	-
TOTAL	277.33	471.76
GRAND TOTAL		4382.06

BOUNDARY	ACRE	HECTAR
PUTRAJAYA	10,600	4,289.67
SURROUNDING PUTRAJAYA	4,382.08	1,773.37
TOTAL LAKE CATCHMENT	14,982.08	6,063.04

TABLE 2.2 : PROPOSED LANDUSE MASTERPLAN FOR PUTRAJAYA LAKE CATCHMENT (ACRE) OUTSIDE PUTRAJAYA

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

2.2.5.3 UPM

(1) A total of 1420 acres (575 ha.) of UPM lies in the catchment area, of which 73% are green areas.

(2) The current development of UPM is in line with the Putrajaya development concept i.e preservation of the green environment However, appropriate waste management measures have to be taken for the committed UPM Hospital development, located at the edge of the northern side of its boundary.

(3) UPM has plans in the future to build an Asian games village next to its existing stadium, a faculty at the northern end of the proposed ERL or next to the Project College and staff quarters within the catchment. Also, there is a need to control the development in certain 'Flexible Zone' areas defined by UPM in its development plan.

2.2.5.4 MARDI

(1) A total of 1148 acres (465 ha.) of MARDI lies in the catchment area. To support the development objectives of Putrajaya, MARDI has relocated most of its live stocks rearing activities, which are a potential pollutant source. Currently, there are only a few farms operating on a small scale, rearing chicken, sheep, duck, ostrich, cow, etc in MARDI's area.

(2) There is no committed development around the area except for the currently under construction, South Klang Valley Expressway (SKVE) and the proposed Express Rail Link (ERL) at the Southern end of MARDI.

(3) In line with a directive from the Ministry of Agriculture MARDI is in the process of drawing-up a development plan that will develop MARDI into a fruit, herbal, flowers and forest theme park, which harmonises with the Taman Wetlands and Taman Botany in Putrajaya at its Southern border.

2.2.5.5 IOI

(1) The IOI development, with a size of 418 acres or 170 ha, is located next to the Upper-East wetlands. Most of the development is located in the catchment area, including Bukit Bisa. A total of 42% of the area is reserved for green areas.

(2) 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.

2.2.5.6 TNB

This site is currently being used as a gas turbine power plant by TNB with an area of 223 acre (90 ha).

2.2.5.7 West Country Berhad

This area is currently planted with oil palm and rubber trees. However, plans are being made to develop a low-density housing development on 381 acres (154 ha.) on the Western part of the site that lies within the Lake Catchment.

2.2.5.8 UNITEN

UNITEN has been zoned for institutional use. The area within the catchment of 94 acres (38 ha) is currently planted with rubber trees.

2.2.5.9 Cyberjaya Flagship Zone

(1) The land-use in this area are zoned for housing, commercial and administration centre, with 30% given to open space.

(2) The Consultant of Cyberjaya would like to complete the earthworks in the vicinity of the Phase-2 Lake before its impoundment. This will minimise potential soil erosion and water quality problems in the future. Thus, they would like to know the expected date of impoundment of the Phase-2 Lake.

2.2.5.10 Sungai Merab Malay Reserve

This area covers 89.6 acres (36 ha) and is currently under rubber cultivation with a few village houses.

2.2.6 Drainage planning

2.2.6.1 The water quantity in the Putrajaya Lake system depends on runoffs flowing into the Lake from the drainage system in the catchment. Thus, it is important that the drainage system in the catchment are planned, designed and constructed to ensure that it does not transport pollutants of any kind into the Lake together with the runoffs.

2.2.6.2 A drainage masterplan has been developed for Putrajaya. There is a need to integrate the existing, committed and future drainage plans in the catchment areas outside Putrajaya, with the Putrajaya drainage masterplan.

2.2.6.3 Figure 2.6 shows the key plan for the existing and recommended drainage systems in the areas outside Putrajaya. The existing and recommended drainage systems in UPM, MARDI, IOI, West Country and Cyberjaya are given in Figures 2.6A to 2.6E, respectively.

2.2.6.4 The existing and proposed drainage plans for the catchment areas outside Putrajaya are described in Section 4.2 of Volume 2 of this Report. They are briefly summarised below.

2.2.6.5 UPM

(1) Details on the proposed drainage system in the UPM area is not available to the Consultant. Thus, it is not possible for the Consultant to comment on UPM's proposed drainage plan. However, since 74% of the UPM areas (within the Lake catchment) are green areas the Consultant believes that it will not be too difficult for the UPM to comply with the general and specific drainage guidelines recommended for the UPM area in this study.

(2) Figure 2.6A indicates that the existing drainage system within the UPM area has a number of existing detention and fish ponds The drainage systems of the proposed ERL and SKVE are to be integrated to the existing streams in the area. In the integration process all existing streams in the UPM area that are affected by the proposed construction works are to be upgraded with the provision of vegetated landscape riparian buffers. Also, the drainage system connecting the ERL and

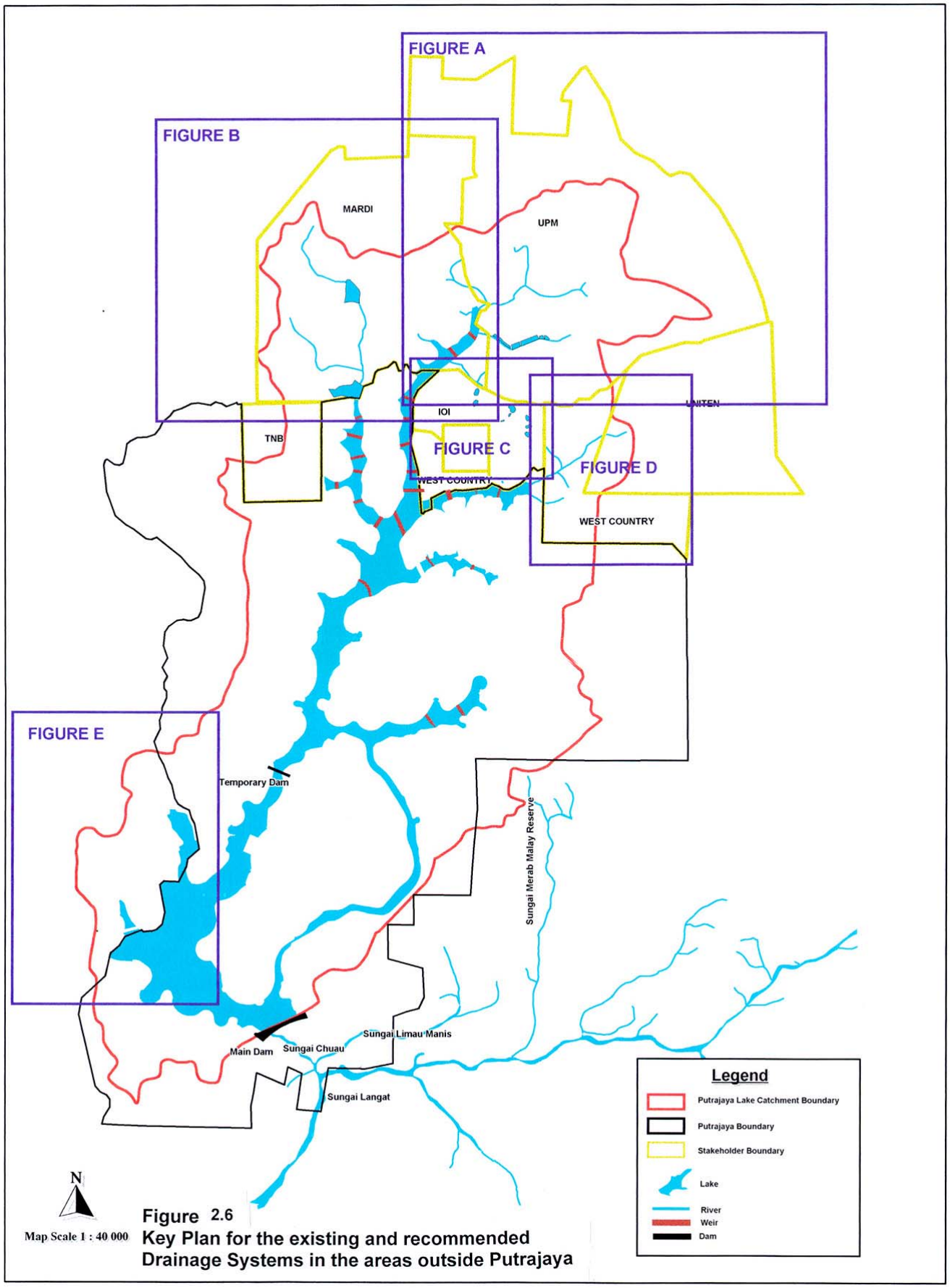


Figure 2.6
Key Plan for the existing and recommended Drainage Systems in the areas outside Putrajaya

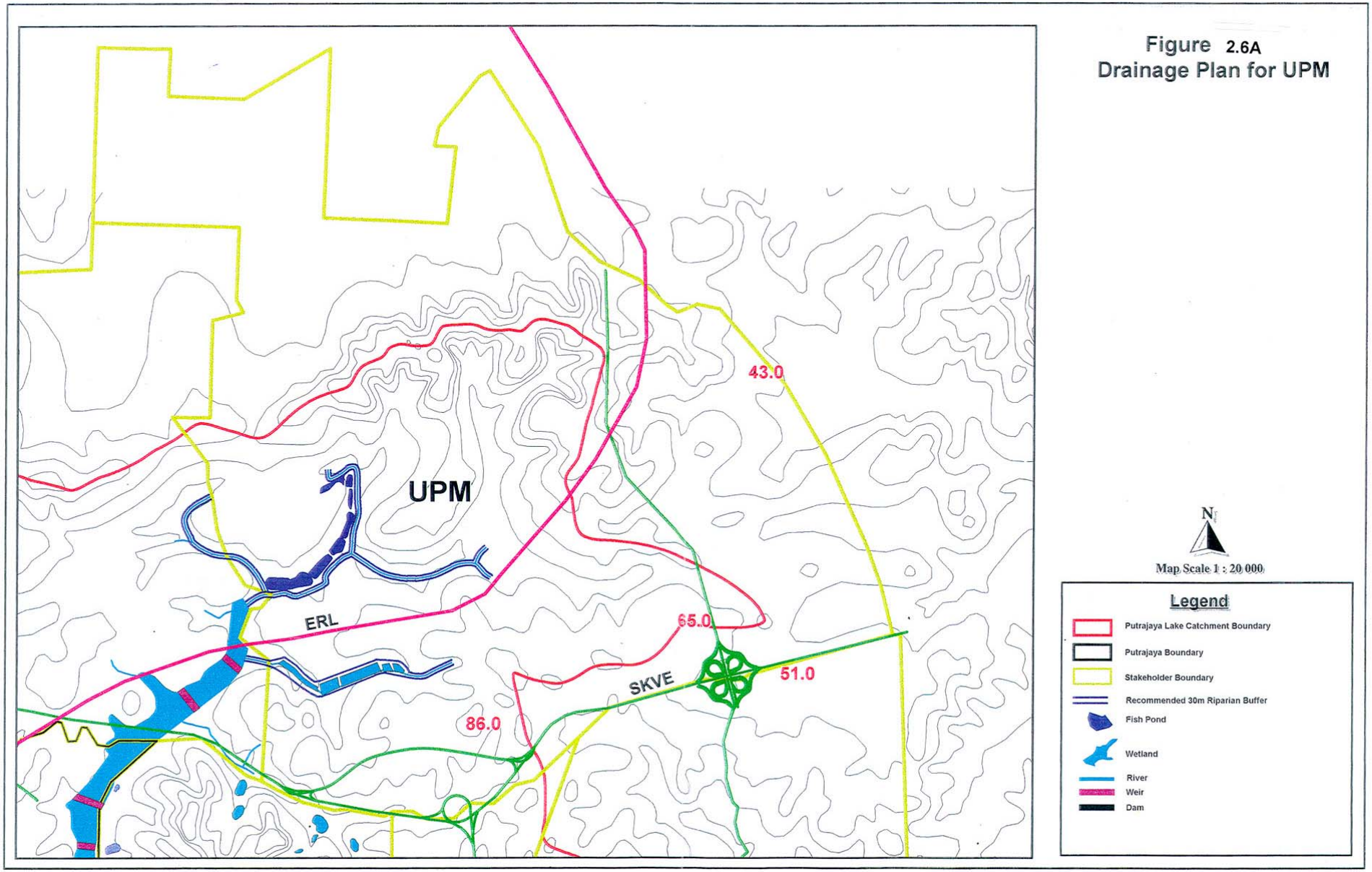


Figure 2.6A
Drainage Plan for UPM

SKVE to the vegetated landscape streams are to be provided with GPTs and sediment traps. *The situation is especially urgent since the land clearing and earthwork phase for the SKVE and ERL in the area has already started.*

2.2.6.6 MARDI

(1) Similarly to the UPM, 74% of MARDI areas within the Lake catchment are green areas. MARDI is proposing to develop the area into a fruit, herbal, flowers and forest theme park, which harmonises with the Taman Wetlands and Taman Botany in Putrajaya at its Southern border. Thus, MARDI will most probably have no difficulty in implementing the recommended vegetated landscape drainage corridor concept.

(1) Figure 2.6B indicates that the existing drainage system comprises of a large flood detention pond. There is a need to integrate the proposed ERL and SKVE drainage systems into the existing drainage system, which eventually flows into the Upper West wetlands. *The situation is especially urgent since the land clearing and earthwork phase for the SKVE and ERL in the area has already started.*

(2) In the integration process it is recommended that all existing streams in the MARDI area that are affected by the proposed construction works are to be upgraded with the provision of vegetated landscape riparian buffer and mini wetlands cum detention ponds, where pertinent. Also, the drainage system connecting the ERL and SKVE to the vegetated landscape streams are to be provided with GPTs and sediment traps.

2.2.6.7 IOI

(1) This area can be divided into 5 sub-catchments. The drainage system in this area comprises of a series of detention ponds draining into the Upper North and Upper East Wetlands. There are two existing drainage outlets. They are North-pointing and drains to the roadside drains connecting to the Upper North Wetlands.

(2) It is recommended that the culverts/drains connecting the 3 ponds discharging into the Putrajaya wetlands be provided or

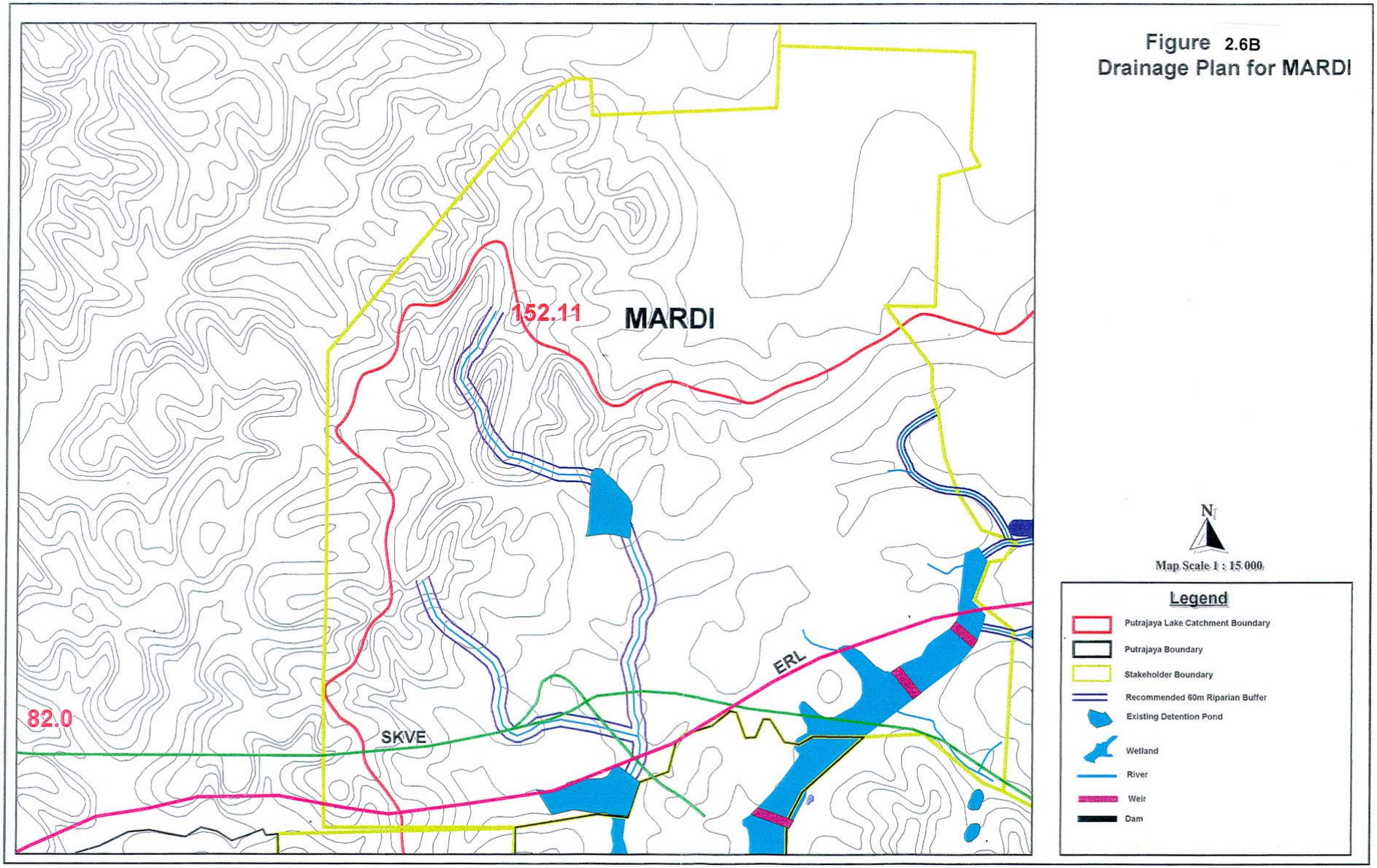


Figure 2.6B
Drainage Plan for MARDI

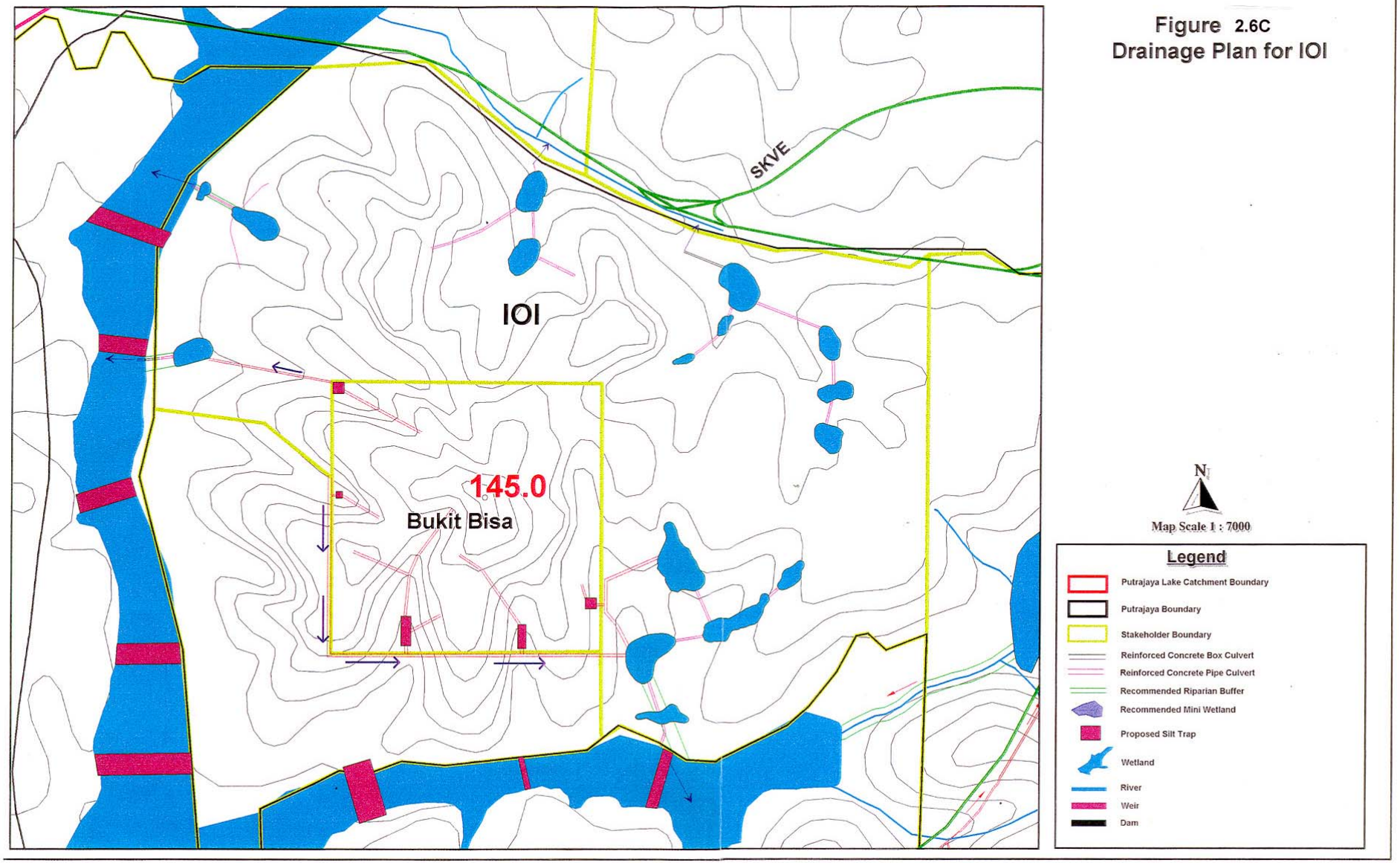


Figure 2.6C
Drainage Plan for IOI

replaced with earth-drains coupled with vegetated landscape drainage buffers.

2.2.6.8 West Country Berhad

(1) West Country Bhd. is planning to develop a low-density housing scheme in the area. The proposed drainage system for the scheme comprises of an 18.3 acre (7.3 ha) flood detention and recreational lake. However, the proposed lake is cut into two by the proposed road access from Putrajaya linking to the SKVE.

(2) The proposed drainage system for this area comprises of a 4.4 ha (11 acres) flood detention and recreational lake cut into two parts by the proposed Putrajaya-SKVE access road. A concrete drain has been proposed to replace the existing stream connecting the downstream lake with the Putrajaya wetland.

(3) It is recommended that the proposed lake should be created without any major earthworks by using the existing contours of the land.

(4) It is recommended that the existing stream connecting the downstream part of the lake to the Putrajaya wetland should be preserved and converted into a vegetated drainage corridor. Also, all the concrete drains in the proposed drainage system leading into the two parts of the lake are to be provided with GPTs.

2.2.6.9 Cyberjaya Flagship Zone

(1) The proposed drainage system by the Cyberjaya consultant makes all runoff flows into proposed water quality enhancement ponds before discharge into the Putrajaya Lake. To remove gross pollutants from the runoff GPTs have been provided in all outlets into the ponds.

(2) To improve the quality of the runoff flowing into the Lake the Consultant recommends that, the drainage system should be based on vegetated landscape drainage corridors and conversion of the water quality enhancement ponds into mini-wetlands. Also, all drainage lines should terminate at water quality enhancement ponds converted into mini-wetlands.

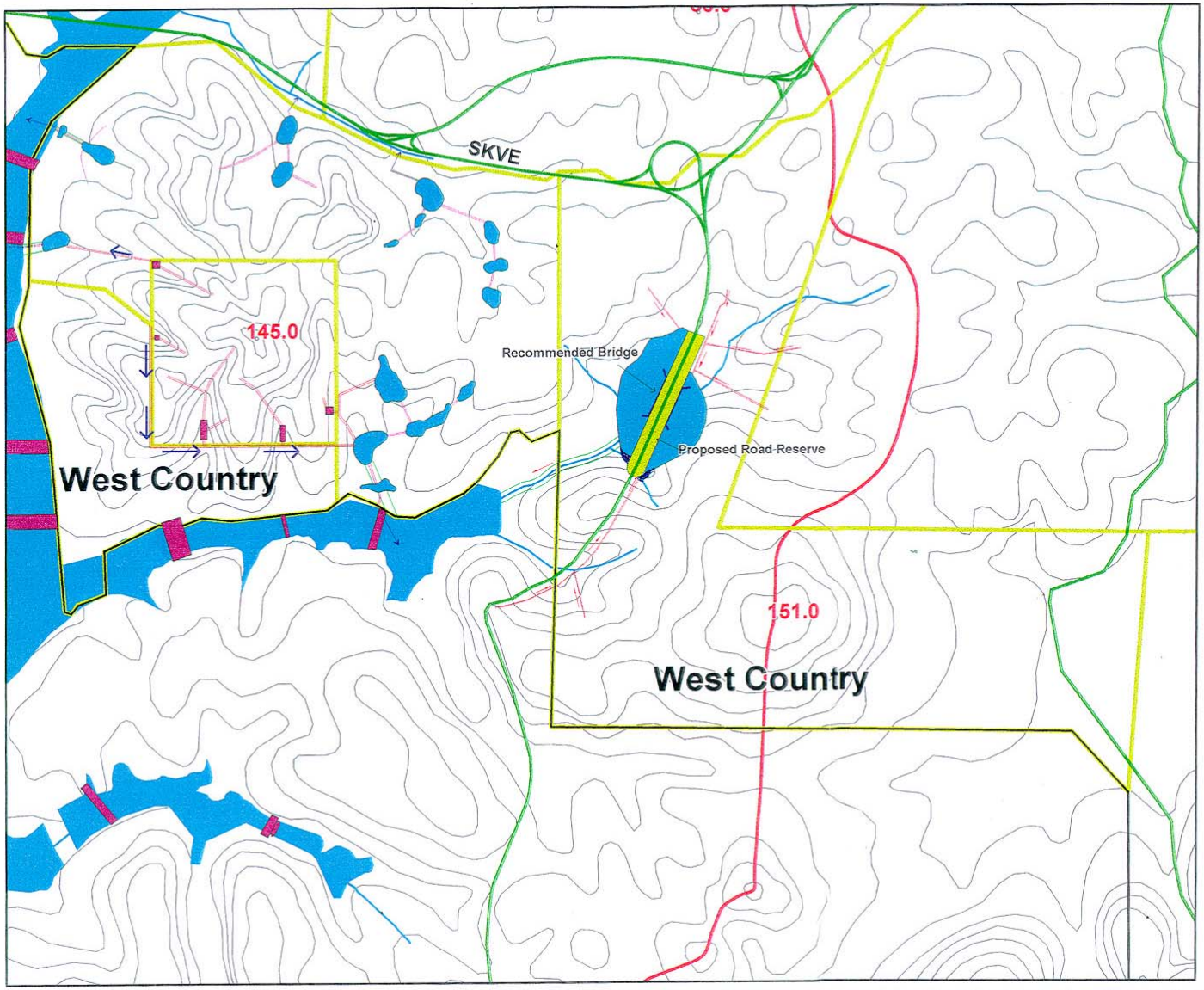


Figure 2.6D
Drainage Plan for West Country

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Map Scale 1 :13 000

Legend

- Putrajaya Lake Catchment Boundary
- Putrajaya Boundary
- Stakeholder Boundary
- Recommended Riparian Buffer
- Proposed Silt Trap
- Wetland
- River
- Weir
- Dam

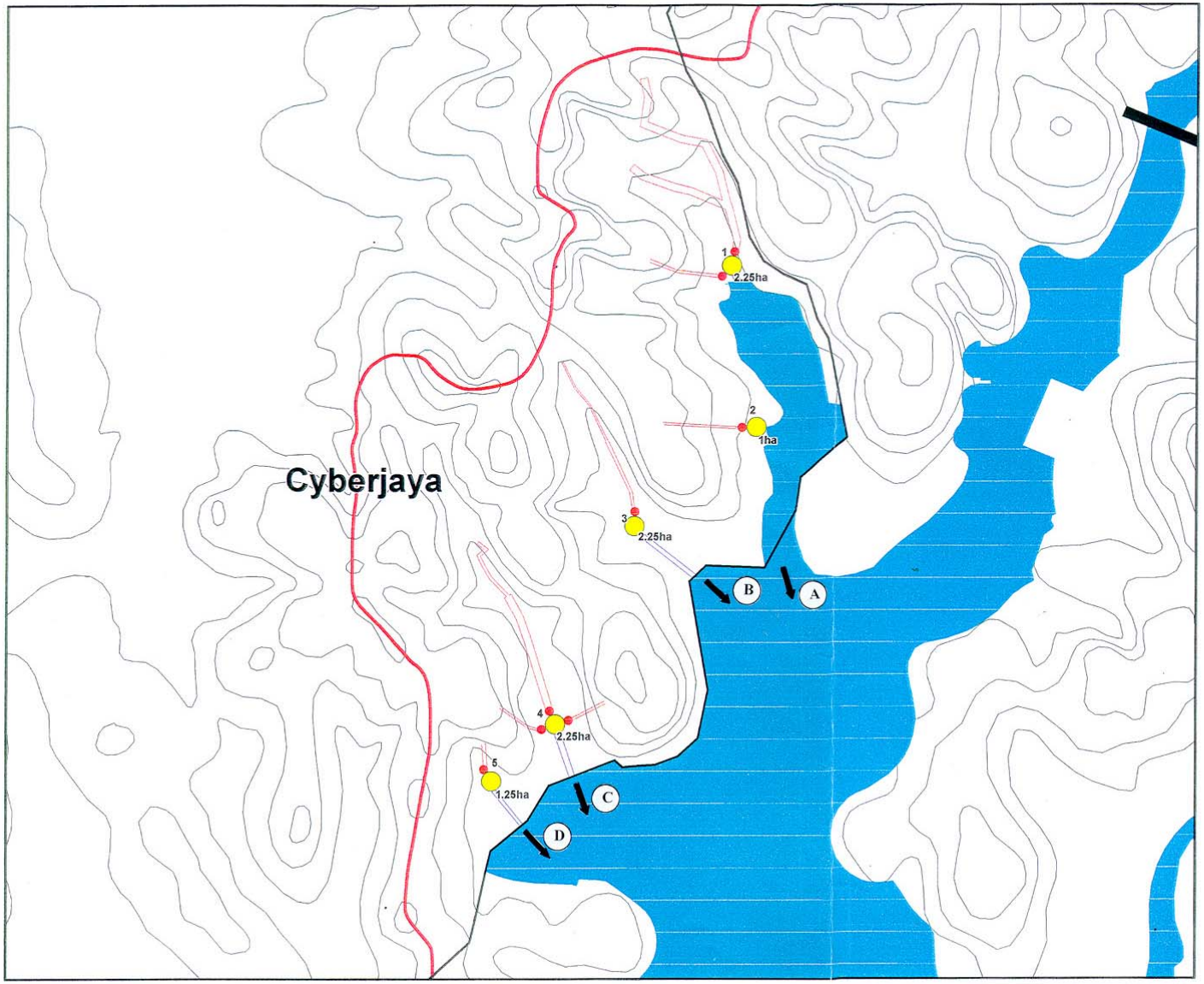

Figure 2.6E
Drainage Plan for Cyberjaya

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Map Scale 1 :13 000

Legend

- Putrajaya Lake Catchment Boundary
- Putrajaya Boundary
- Drainage
- Proposed GPT
- Water Quality Pond
- Recommended Riparian Buffer
- Lake
- Weir
- Dam

2.2.7 Sewerage Planning

2.2.7.1 Sewage effluent discharge is considered a potential point source pollutant into the Putrajaya Lake. The proper collection, treatment and disposal of residual (sludge) will ensure the treated sewage effluents ultimately discharging into the Putrajaya Wetlands and Lake do not create any adverse effects on the required lake water quality.

2.2.7.2 A sewerage masterplan has been developed for Putrajaya. There is a need to integrate the existing, committed and future sewerage plans in the catchment areas outside Putrajaya, with the Putrajaya drainage masterplan.

2.2.7.3 The existing and proposed sewage treatment system for the catchment areas outside Putrajaya are described in Section 5.4 of Volume 2 of this Report. Figure 2.7 shows the locations of the existing and proposed sewage treatment plants in the catchment. They are described briefly below.

2.2.7.4 UPM

(1) The current sewage load from UPM is 4925 Population Equivalent (PE).

(2) There is no sewage collection system or sewer reticulation to convey sewage flows from the various buildings in UPM to a central sewage treatment plant.

(3) Individual sewage treatment plant(s) are provided for each building to treat the sewage flows from the buildings before discharging into the streams and ponds, which finally flow into the Upper North Wetlands.

(4) Sewage flows from Kolej 8 and Kolej 9 are treated by an Imhoff Tank and three septic tanks, respectively. The sewage treatment septic tanks, consisting of simple compartments for scum/ sludge digestion and settlement, and a simple filter media are not capable of producing sewage effluent discharge that can meet DOE's Standard A requirement. The level of sewage treatment in the tanks is further strained from the over loading of

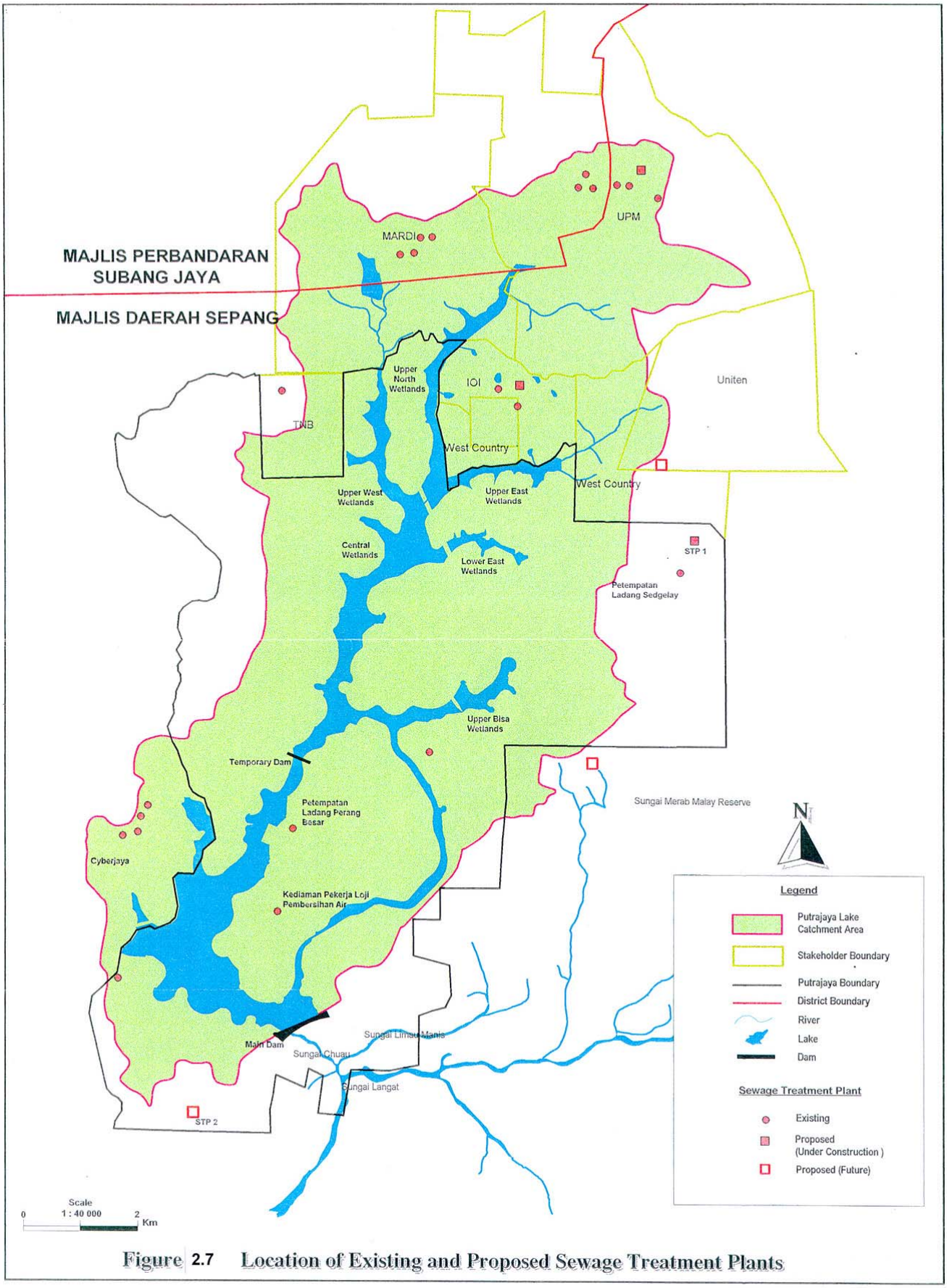


Figure 2.7 Location of Existing and Proposed Sewage Treatment Plants

the sewage flows resulting from more students per room in the hostels.

(5) A packaged activated sludge treatment plant of capacity 2,000 PE treats sewage flows from Kolej Matrikulasi. The two-year-old treatment plant has been in operation without any major reported problems. However, there is no sampling and testing of the treated effluents from the plant to check that DOE's Standard A effluent requirements are met.

(6) A privatised hostel project known as Kolej Baru is currently under construction and is expected to be completed by 2000/2001. The proposed sewage treatment plant for this Kolej is based on the extended-aeration activated sludge system and has a total capacity of 7000 PE. The treated effluent, meeting DOE's Standard A will be discharged into the existing UPM ponds in series and finally into the Upper North Wetland.

(7) No information is available on the sewage treatment system for the proposed UPM Hospital project.

2.2.7.5 MARDI

(1) The current sewage load from MARDI is 600 PE.

(2) All of the sewage flows from MARDI's head office and associated buildings, together with the living quarters, are treated by septic tanks. The effluents from the tanks are discharged into the existing open drains, flowing through low land, ponds, streams and finally into the Upper North Wetlands.

(3) The treated effluents are likely to meet DOE's Standard B. However, the total effluent quantity is small and estimated at 135 m^3/day or 0.0016 m^3/s for 600 PE. In addition, the mixing of the effluents with stream water along grass-lined channels will greatly enhanced the quality of the combined flow.

2.2.7.6 IOI

(1) The total sewage load from IOI is 7761 PE.

(2) The existing sewage treatment system consists of two small packaged Super-Sept (Trade name) tanks and one aerated lagoon sewage treatment plant.

(3) The effluents from the system are discharged into the existing golf landscaping cum retention ponds, which are connected to a stream leading to the Upper North Wetland.

(4) The Jabatan Perkhidmatan Pembentungan (JPP) has approved a proposed mechanised sewage treatment plant, with extended aeration activated sludge process, to serve the entire development sewage load of 7761 PE. The treated effluent is designed to meet DOE's Standard A and discharges into a retention pond, which flows into the Upper North Wetland.

(5) There is no monitoring of the water quality of the combined discharge of surface runoff and treated effluents at the outlet of the retention pond. However, it is anticipated that the final discharge into the Upper North wetlands will not have any adverse pollutant overloading impact on the wetlands, in view of the holding period and dilution of the effluent in the retention pond. The pond, acts to some extent, as a maturation pond for polishing the soluble organic wastes of the treated effluent.

2.2.7.7 TNB

The effluent from this area discharges outside of the catchment. Thus, there will not be any impact on the Putrajaya Lake water quality.

2.2.7.8 West Country Berhad

The developer has told the Consultant that they are planning to pump the sewage, arising from the proposed low density development in the area within the catchment, for treatment outside the catchment. Thus, there will not be any impact on the Putrajaya Lake water quality.

2.2.7.9 Cyberjaya Flagship Zone

(1) The proposed Cyberjaya Sewerage Plan for the Flagship Zone is based on the following planning and implementation strategies:

- All sewered sewage flows for the whole Cyberjaya will be transferred to a permanent centralised sewage treatment plant located in the south-west of the Cyberjaya Development.
- All sewered sewage flows from the Cyberjaya Flagship Zone will be treated by a proposed temporary sewage treatment plant located at the western part of the Flagship Zone.
- The early and initial developments within the Flagship Zone will have their own temporary sewage treatment plants to treat the sewered sewage, respectively. The sewage flows will later be transferred to the Flagship Zone major temporary sewage treatment plant.
- *The sewage flows in Phase 1B of the Flagship Zone (i.e. within the Lake catchment) will eventually be transferred, treated and discharged outside the catchment.*

(2) One parcel of land of about 27 hectares of low density residential development (Country Heights Development) is located south of Phase 1B and will be implemented in the very near future. (The implementation date is not confirmed). A small temporary sewage treatment plant of capacity 560 PE will be built for this planned development. The treated effluent from the plant will be discharged into the Putrajaya Lake, downstream of the temporary dam.

(3) There are four existing temporary packaged sewage treatment plants catering to the initial sewage treatment needs of the early developments in Cyberjaya, which are located within Phase 1B of the Flagship Zone of Cyberjaya. As a temporary measure, the treated effluents are currently discharged downstream of the temporary dam. This will have to be relocated, as planned, when the Phase 2 main Dam is impounded.

2.2.8 Planning and land-use control

2.2.8.1 Planning and land use control of areas within the catchment represents one of the most important mechanisms for the protection of the water quality in the Lake. This is due to the impact that a change in land use has on the drainage and hydrology of the river and lake system. In addition, activities that are undertaken in an area as a result of changes in the allowable land use, has potential to generate pollutants which affect water quality.

See Vol-2, Section 8.2.3.1 Planning and Land-use control

2.2.8.2 The planning and land use management within Putrajaya and Cyberjaya is expected to be effective since detailed Master Plans have been drawn up for the two areas. In the case of Putrajaya, the mechanism and set-up for control and management of planning is well organised compared to those of the other 2 local authorities in the catchment, Majlis Daerah Sepang (MDS) and Majlis Perbandaran Subang Jaya (MPSJ).

2.2.8.3 The catchment areas outside of Putrajaya are managed by the 2 local authorities, MDS and MPSJ. Structure Plans have been prepared for the two local council areas but Local Plans have yet to be made and gazetted for the areas within which the Putrajaya Lake Catchment lies. Ad-hoc applications for conversion of land is likely to occur and the decision to allow such conversions lies with the State and not with the local authorities.

2.2.9 Drainage management and control

2.2.9.1 There is no integrated approach to this issue since the responsibilities for drainage lies with the JPS, the local authorities and other agencies such as the JKR and other developers.

See Vol-2, Section 8.2.3.2 Drainage Management and Control

2.2.9.2 All runoff and discharges into drainage systems ultimately flow into rivers, which are the main source of water for the lake. The integrated management of drainage and the river system is important and needs to be addressed.

2.2.9.3 Control of the quality of runoff represents one of the issues that need to be given attention.

2.2.10 Environmental management and pollution control

2.2.10.1 The two local authorities, MDS and MPSJ, have set-ups that are similar, except that the latter is more organised and better staffed, as it is a municipality. However, compared to the Perbadanan, there is presently no organisation in both local authorities to effectively manage environmental issues, such as control of water pollution, runoff management and others that have an effect on the Lake water quality.

See Vol-2, Section 8.2.3.3 Environmental Management and Pollution Control

2.2.10.2 The responsibilities of Jabatan Alam Sekitar (JAS) is mainly directed towards point sources of pollution and its jurisdiction limited to specific concerns such as industrial pollution (see Vol-2, Section 8.1.6.7 Environmental Protection).

2.2.10.3 The local authorities need to be expanded to manage and control non-point sources of pollution which is expected to be more important in the management of the Putrajaya Lake Catchment. Hence the enforcement functions of local authorities should not be confined to that related to public health, traffic and businesses but to be expanded to include environmental quality management.

2.2.11 Co-ordination between regulatory agencies

2.2.11.1 There is a need for co-ordination between the 2 local authorities and the various government agencies and departments to manage the development and human activities in the catchment.

2.2.11.2 The Federal Government has recognised this fact and has formed the Putrajaya Lake Management Committee (PLMC) to facilitate this process. However, the PLMC is an administrative Committee and has no legal powers.

See Vol-2, Section 8.2.2.7 Putrajaya Lake Management Committee

2.2.12 Monitoring and Review

2.2.12.1 There is a need to monitor the effectiveness of the implementation of the Plan in attaining the desired environmental objectives for the Lake catchment. To support the Lake Management Committee's monitoring and review on the effectiveness of the implementation of the various management programs in the Plan there is a need to monitor the following:

- Hydrological information in the catchment
- Water quality in the Lake, wetlands and at the drainage inlets into the Lake system.
- Health of the flora and fauna in the wetlands

2.3 THE CURRENT SOLUTIONS

2.3.1 Since Putrajaya occupies 70% of the catchment and Putrajaya Lake is an integral part of Putrajaya the Federal Government, through the Perbadanan, has provided funds to develop a number of plans and guidelines to support the management of the catchment.

2.3.2 The following are the pertinent plans and guidelines that have been developed:

- The Putrajaya Masterplan and Urban Design Guidelines
- The Putrajaya Environmental Management Guide
- The Putrajaya Stormwater Management Design Guide
- The Putrajaya Lake Management Guide

CHAPTER 3
THE CATCHMENT MANAGEMENT AND DEVELOPMENT PLAN

3.0 THE CATCHMENT MANAGEMENT AND DEVELOPMENT PLAN

3.1 WATER QUALITY MANAGEMENT

3.1.1 The implications of the conclusions from the water quality modelling study is that *the most effective way to attain the desired water quality objectives for the Lake is to minimise the generation of pollutants at their source*. Thus, the Consultant recommends that effective measures should be carried out to minimise pollutant generation at their source.

3.1.2 This may be done in two ways: control of point sources and control of non-point sources. Point sources may be controlled by structural measures (e.g. GPTs sewage treatment plants); non-point sources by land management measures such as vegetated riparian buffers and drainage corridors. The latter is especially critical during the current development phase of Putrajaya, where the erosion and transport of sediments from the land clearing, earthworks and construction activities, results in significant TSS pollution of the Lake and wetlands. (See Figures 3.1 and 3.2).

3.1.4 In view of the observed positive effects on the reduction of TSS and Total Phosphorus in the grass-lined streams in UPM and MARDI the following are some specific recommendations for enhancing the quality of the runoffs (after minimisation of pollutants at source) in the catchment before they reaches the Lake:

- The wetlands should be considered as an *additional (last stage)* water quality enhancement or "polishing" mechanism. *It should be integrated with upstream water quality enhancement features, such as vegetated landscape riparian buffers, drainage corridors and upstream mini-wetlands flood detention ponds (see Figure 3.3. and 3.4)*, wherever possible.

- The drainage system should be vegetated landscaped drainage corridors with mini wetlands flood detention ponds.

Figure 3.1 **Stormwater runoff wetlands can introduce nutrients and sediments loading**

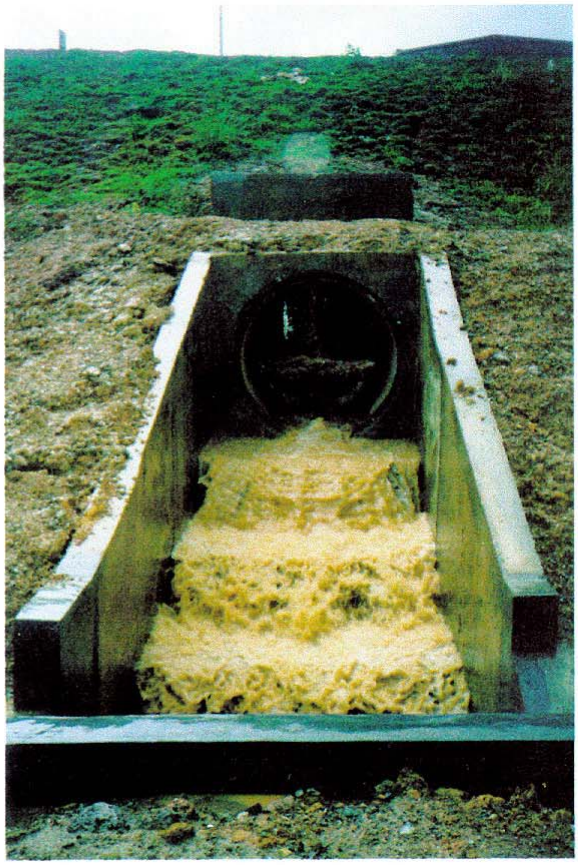


Figure 3.2

Bare soil at the side of welands cells can contribute to nutrients and sediment input during rainfall

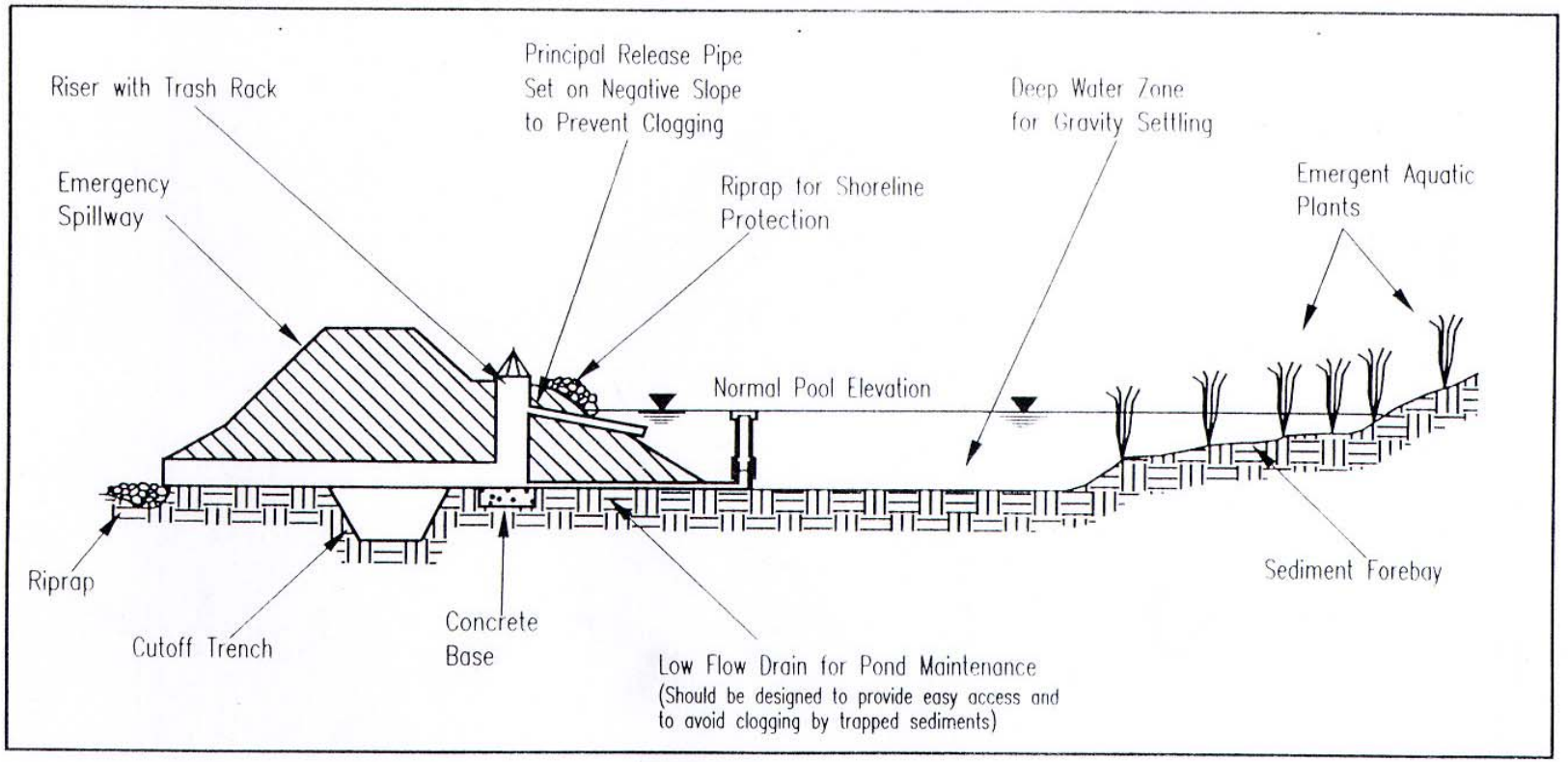


Figure 3.3 Typical wet pond profile.
(Source: Engineers & Surveyors Institute and Northern Virginia District Planning District Commision)

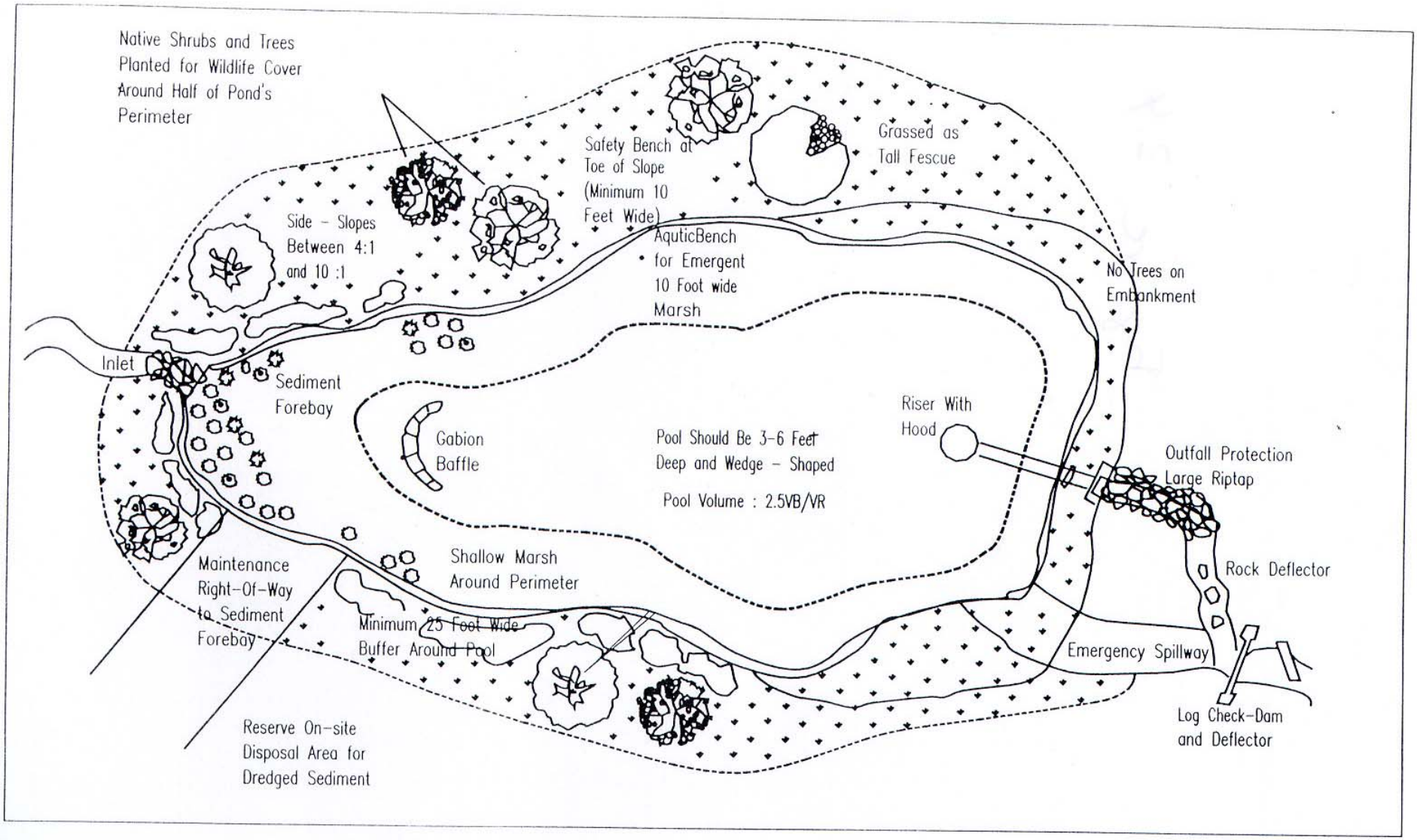


Figure 3.4 Design schematic of a wet pond. (Source: Schueler, 1987)

- The DID guideline that 5% of any development areas should be reserved for flood detention ponds supports this concept.

- A team comprising of an environmentally-conscious drainage engineer and a landscape architect should be able to design unique, aesthetically-pleasing and functionally-effective vegetated drainage corridor systems, given such land area for a drainage system.

- The vegetated drainage corridor/mini-wetlands concept is in harmony with Putrajaya's vision of a quality living environment. The drainage corridor/mini-wetlands can be integrated into neighbourhood parks, providing each neighbourhood park with the natural green and water environment that are symbols of a quality living environment. It can also form the backbone for the green network corridors, for pedestrians and bicycle paths, connecting the residential, commercial and recreational areas in a development.

- To ensure a "rubbish-free" drainage corridor, gross pollutant/sediment trap (GPT) structures are to be installed at the ends of all concrete drains flowing into the vegetated landscape drainage corridors. To minimise maintenance of the GPT structures the CDS-type GPT as shown in Figure 3.5 is one option.

3.2 WETLANDS MANAGEMENT

3.2.1 The following are pertinent recommendations related to the management of the wetlands:

1. Future study has to be carried out to determine the more resistant wetland plant species and also the optimum planting density for the various wetland plant species.

2. Detail fish sampling studies have to be carried out to facilitate the control of the domination of fish population by certain species, such as the Tilapia

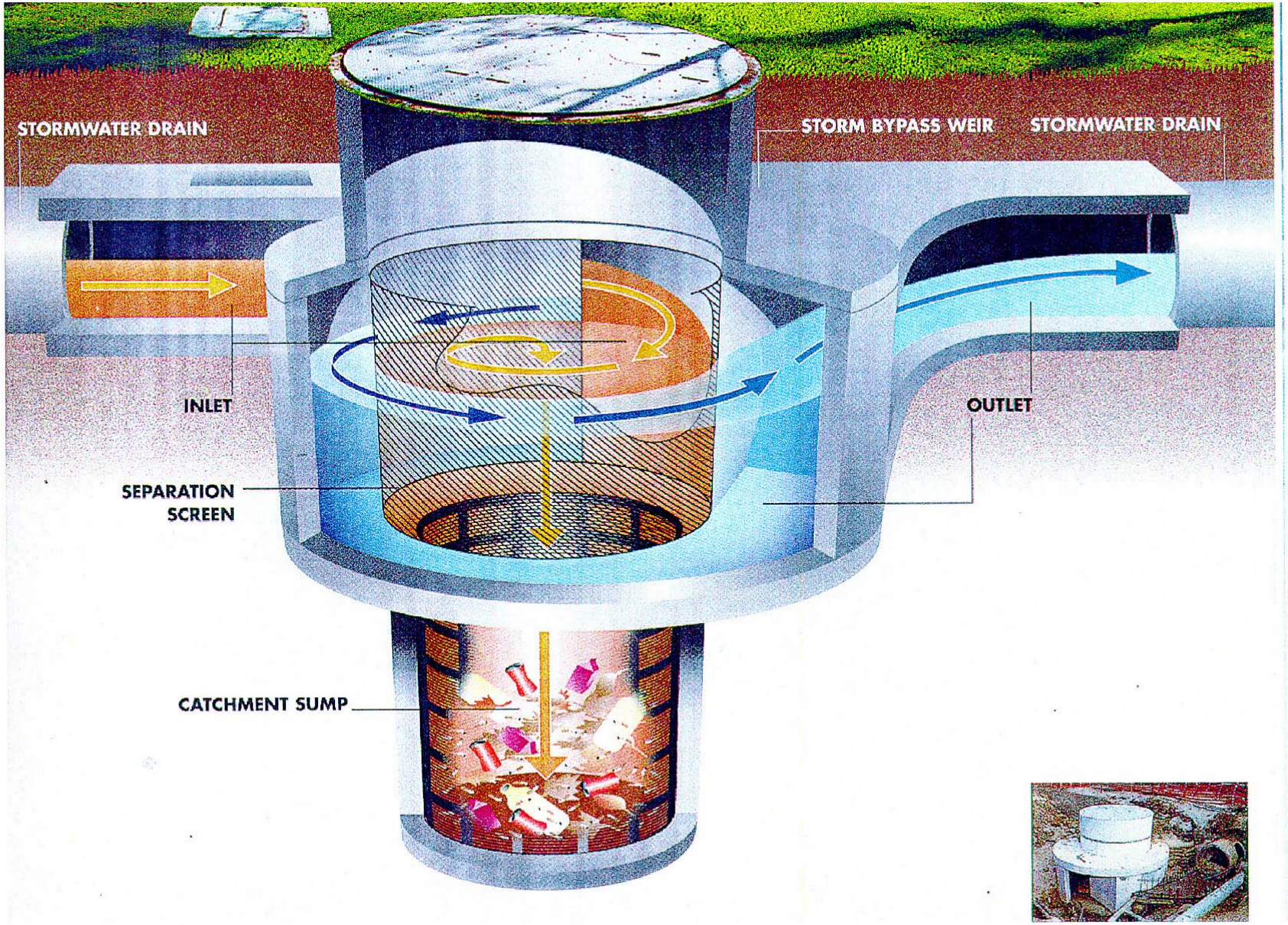


Figure 3.5 : Typical CDS Structure

3.2.2 The Consultant would like to clarify that the observations on the water quality in the wetland and lake and on the wetland flora and fauna are indicative observations made in the course of the study to develop the catchment management plan. It is not within the scope of the Consultant's study to conduct a detail and thorough review of the effectiveness of the wetlands performance.

3.2.3 Further selective and detailed investigations need to be carried out on the ecology of the flora-fauna system of the wetlands in order to provide data and information for future management measures. For the overall hydraulics and water quality, consideration should be given to the availability of options for controlling and intervening into the wetland and lake functions. This includes recycling of water, water level control, reaeration, desilting, shoreline control etc. Again detailed investigation on the specific requirements needs to be carried out.

3.2.4 Thus, it is recommended that a separate wetland and lake study be carried out, with the following objectives:

(i) To conduct a detail assessment of the wetland and lake function and processes given the existing condition
(ii) To identify the possible control measures available to meet the management's requirements.
(iii) To develop the research and monitoring strategies
(iv) To identify structural and non structural measures which may be utilised for optimising and managing wetland and lake functions.

3.3 POLLUTANT SOURCES MANAGEMENT

3.3.1 The 4 primary point pollutant sources arising from the sewage effluent discharges from MARDI, UPM, IOI and Cyberjaya will be managed in the sewerage masterplan described below.

3.3.2 The pertinent authorities (JKR, Perbadanan) are to ensure that appropriate Emergency Response Plans and Procedures are prepared and implemented to handle the emergencies related to the potential point source pollution arising from accidents associated with the oil tankers moving along the road passing through the wetlands.

3.3.3 The non-point pollutant sources from the following areas and the recommended management measures are as follows:

- Runoffs from the road passing through the wetlands
  The drainage system from the roads shall be integrated into the drainage masterplan.

- Runoffs from within Putrajaya area entering directly into the Lake.
  It is recommended that the vegetated drainage corridors coupled with mini wetland flood detention pond drainage systems be used instead of the proposed concrete drain linked to Gross Pollutant and Sediment Traps (GPT) type drainage system.

- Fertiliser and pesticide inputs from MARDI, UPM, IOI and Cyberjaya Flagship Zone maybe a problem.
  BMP guidelines on the use of fertilisers and pesticides have been prepared and are recommended to be followed by the above stakeholders.

3.4 WATER QUANTITY MANAGEMENT

3.4.1 The following are pertinent recommendations related to the management of the water quantity in the Lake:

- No diversion or alteration of the natural drainage lines in the catchment is to be allowed.

- Compensation flow of 0.186 m^3/s may be allowed during the in-filling of the main dam.

- A well field of 6 groundwater wells can be developed, downstream of the main dam, to supply 0.5 m^3/s (10,000 g/hr) of groundwater to meet any water demand.

- Further study on the impact of the proposed rainwater harvesting for domestic and other consumptive uses on the water quantity in the Lake have to be carried out. It may be carried out as part of the proposed irrigation masterplan study below.

- A separate irrigation masterplan study has to be carried out (*see Appendix 3 for the proposed TOR for study*), with the following objectives:
  (i) To conduct a detail assessment of the total irrigation water demands in Putrajaya,
  (ii) To identify the possible irrigation water sources and amounts available from them to meet the irrigation demands,
  (iii) To develop the irrigation strategies to meet the irrigation demands, for various operational scenarios,
  (iv) To prepare a comprehensive integrated irrigation master plan for the whole of Putrajaya development, which shall include the conceptual design of the trunk and secondary distribution mains.

The calibrated Water Quality Model in this Study should be used to evaluate the impact on the Lake water quality for the various proposed irrigation withdrawal scenarios from the Lake. A realistic duration for carrying out the above irrigation master plan study is about **6 months**.

3.5 LAND-USE PLANNING

3.5.1 To ensure that the development in the areas outside Putrajaya, that lies within the Lake catchment, are in line with objectives for the catchment a land-use masterplan for the areas outside Putrajaya has been prepared. Figure 3.6 and and Table 3.1 shows the proposed land-use masterplan for the areas outside Putrajaya. Also, Table 3.2 shows the Use-Class Order Tables describing the allowable land-use activities in each of the land parcels.

3.5.2 To facilitate the JPBD in the preparation of the Local Plan for the areas outside Putrajaya, and to ensure that the pertinent recommendations on land-use, drainage and sewerage development in the areas outside Putrajaya, from this Study report, are incorporated into the Local Plan *Appendix 4 containing the pertinent extracts from this Study Report* have been prepared.

See Vol-2, Section 6.4 The Integrated Land-use Masterplan

3.6 DRAINAGE PLANNING

3.6.1 Drainage Planning and Design Guidelines

3.6.1.1 To ensure uniformity in the drainage design standards for the catchment it is recommended that the Putrajaya Stormwater Management Design Guide be made applicable for all the drainage design in the catchment.

See Vol-2, Section 4.3 Drainage Planning and Design Guidelines

3.6.1.2 To improve the quality of the runoff flowing into the Lake it is recommended that, wherever possible, the drainage system should be based on vegetated landscape drainage corridors and conversion of flood detention ponds into mini-wetlands. Also,

FIGURE 3.6
PROPOSED INTEGRATED LANDUSE MASTERPLAN

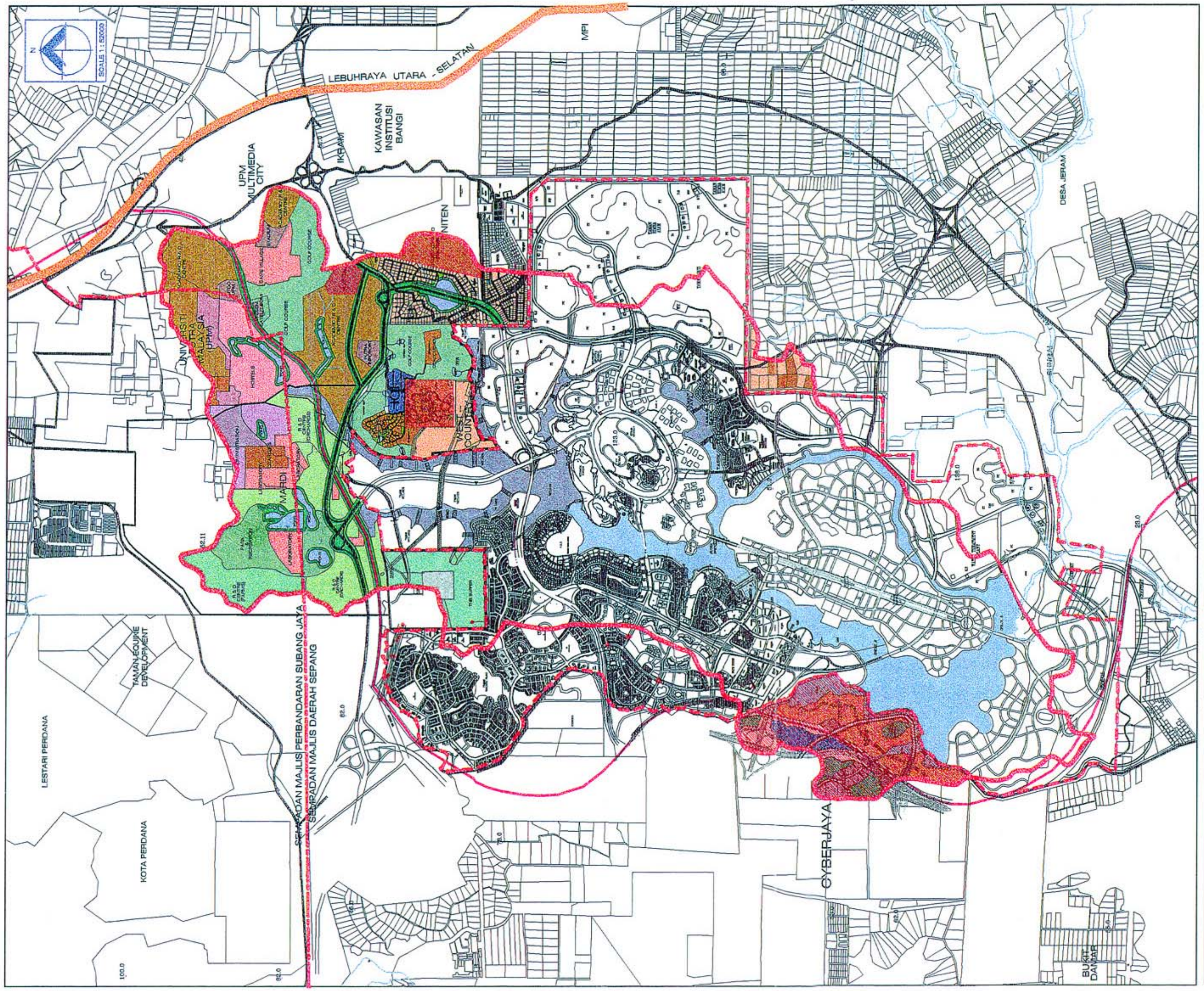


FIGURE :

TITLE : PROPOSED INTEGRATED LANDUSE MASTERPLAN

CATCHMENT DEVELOPMENT AND MANAGEMENT PLAN FOR PUTRAJAYA LAKE

LEGEND :-

BUILDINGS	EXISTING	ACRE	COMMITTED	ACRE	PROPOSED	ACRE	FUTURE LANDUSE	%
HOUSING / QUARTERS		101.47		197.47		303.46	598.81	32.71
COMMERCIAL		17.46		12.15		-	29.61	1.62
HOSTELS/COLLEGE		59.76		-		153.92	213.68	11.67
TNB POWER STATION		28.95		-		-	28.95	1.58
ADMINISTRATION/OFFICE		71.12		66.45		80.26	217.83	11.90
ACADEMIC/R & D		-		-		406.69	406.69	22.22
FACILITIES		92.35		86.06		165.27	343.68	18.29
TOTAL		371.11		359.13		1100.74	1830.98	41.77
GREEN								
AGRICULTURE		842.33		-			-	
GOLF COURSE		403.41		-		403.41	403.41	25.23
BUFFER ZONE		194.03		-		25.75	219.76	13.84
ORCHARDS		742.96		-		354.96	354.96	22.20
FARMS		723.66		-		141.21	141.21	8.83
OPEN SPACE/RECREATION		246.23		117.29		163.36	506.69	29.91
TOTAL		2970.23		117.29		1061.72	1599.06	36.49
WATER BODIES								
LAKE/POND		63.28		51.03		42.22	156.53	76.91
WETLAND		46.99		-		-	46.99	23.09
TOTAL		110.27		51.03		42.22	203.52	4.64
OTHERS								
ROAD/DRAINAGE		242.85		-		-	242.85	32.42
EXPRESS RAIL LINK		-		157.95		-	157.95	21.09
HIGHWAY		-		277.98		-	277.98	41.89
OTHERS		34.48		-		-	34.48	4.60
TOTAL		277.33		471.76			749.09	17.09
GRAND TOTAL							4382.08	100.00

BOUNDARY	ACRE	HECTAR
PUTRAJAYA	10,600	4,289.67
SURROUNDING PUTRAJAYA	4,382.08	1,773.37
TOTAL LAKE CATCHMENT	14,982.08	6,063.04

TABLE 3.1 : 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

TABLE 3.2 : LAKE CATCHMENT LANDUSE MASTERPLAN – USE CLASS ORDER

LAKE CATCHMENT AREA (PLOT)	PERMITTED USE	PERMITTED WITH CONDITION		NON PERMITTED USE
UPM	**INSTITUTIONAL**	**Activities**	**Conditions**	
Institutional Centre Total Area: 1,389.80 acre	• Hostels/Collage • Faculty • Administration Centre • R&D Centre • Farms & Orchards • Open Space/Feild • Mosque • Library • Laboratory	• Hospital • Housing • Commercial • Food court • Pedestrian walk • Buffer Zone • Lake/pond • Sewerage Treatment Plant • Golf Course • Public facilities • Sports Complex • Recreations • Road/Drainage • Highway/ERL	• Must follows Planning Standard Guidelines, Lake Catctment Guidelines, Putrajaya Guidelines and MSC Guidelines. • 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 • Fetilizer & pesticide use is controlled and monitored. • Stream flow to be preserve • EIA study to be carry out.	• Industry • Land earthwork clearing more than 15% of catchment • Development with pollution - excess fertilizers, herbicides, and insecticides from agricultural lands and parks - bacteria and nutrients from livestock, wildlife, pet wastes and sewerage system
MARDI	**REASEARCH CENTRE**	**Activities**	**Conditions**	
Research Centre Total Area: 1,204.58 acre	• Administration Office • R&D Centre • Laboratory • Store • Farms & Orchards • Nursery •	• Housing/Quarters • Hostels • Commercial • Public facilities • Buffer zone • Recreation • Open Space/Feild • Lake/pond • Sewerage Treatment Plant • Golf Course • Road/Drainage • Highway/ERL	• Must follows Planning Standard Guidelines, Lake Catctment Guidelines, Putrajaya Guidelines and MSC Guidelines • 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 • EIA study to be carry out	• Industry • Land earthwork clearing more than 15% of catchment • Development with pollution - excess fertilizers, herbicides, and insecticides from agricultural lands and parks • bacteria and nutrients from livestock, wildlife, pet wastes and sewerage system

TABLE 3.2 : LAKE CATCHMENT LANDUSE MASTERPLAN – USE CLASS ORDER (*cont'd)*

LAKE CATCHMENT AREA (PLOT)	PERMITTED USE	PERMITTED WITH CONDITION		NON PERMITTED USE
IOI	**HOUSING & RECREATION**	**Activities**	**Conditions**	
Country Homes & Golf Course Total Area: 522.91 acre	• Low Density Housing - Bungalow lots - Condominium/Apartments • Commercial - Club House - Nursery Centre - Health Club - Boutique & Salon - Clinic • Sports and recreations • Open Space/Feild •	• Shopping Centre • Exhibition Centre • Medical Centre • Food Stall • Recreation • Lake/pond • Sewerage Treatment Plant • Golf Course • Road/Drainage •	• Must follows Planning Standard, Lake Catctment Guidelines, Putrajaya Guidelines and MSC Guidelines • 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 • Fetilizer & pesticide use is controlled and monitored • Stream flow to be preserve • EIA study to be carry out	• Industry • Development with pollution - sediment from improperly managed construction sites and eroding stream banks. • more than 20% slope (accept recreations)
TNB	**FACILITIES**	**Activities**	**Conditions**	
Power Station Total Area: 222.98 acre	• Power Plant • Green Network - Reserve for electric line - Buffer Zone	• Recreation • TNB Facilities • Open Space/Feild	• Must follows Planning Standard Guidelines, Lake Catctment Guidelines, Putrajaya Guidelines and MSC Guidelines • Enhance and introduce riparian buffer strips (non-point BMP) • Install mitigating measures to prevent pollutant input from the roads crossing the wetland	• Any development accept TNB use
WEST COUNTRY BHD.	**MIXED HOUSING**	**Activities**	**Conditions**	
Mixed Housing Total Area: 276.37 acre	• Low Density Housing - Bungalow lots - Condominium/Apartments (40 upa) - Tarrace House (12 upa) • Public Facilities • Open Space & Recreation - Neighbourhood Playground - Playlot - Green Network •	• Commercial • Shopping Centre • Medical Centre • Institutional • Lake/pond • Sewerage Treatment Plant • Sports & recreations - Town Park • Offices • Road/Drainage • Highway	• Must follows Planning Standard, Lake Catctment Guidelines, Putrajaya Guidelines and MSC Guidelines • Low-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 • Fetilizer & pesticide use is controlled and monitored • Stream flow to be preserve • EIA study to be carry out	• Industry • Development with pollution - sediment from improperly managed construction sites and eroding stream banks. • more than 20% slope (accept recreations)

TABLE 3.2 : LAKE CATCHMENT LANDUSE MASTERPLAN – USE CLASS ORDER (*cont'd)*

LAKE CATCHMENT AREA (PLOT)	PERMITTED USE	PERMITTED WITH CONDITION		NON PERMITTED USE
CYBERJAYA	**MIXED HOUSING & OFFICES**	**Activities**	**Conditions**	
Mixed Housing & Offices Total Area: 607.04 acre	• Low Density Housing - Bungalow lots - Condominium/Apartments (40 upa) - Tarrace House (12 upa) • Commercial • Office • Public falities • Open Space/Feild •	• Shopping Centre • Medical Centre • Food Stall • Institutional • Commercial • Recreation • Lake/pond • Sewerage Treatment Plant • Golf Course • Sports & recreations • Road/Drainage • Highway/ERL	• Must follows Planning Standard, Lake Catctment Guidelines, Putrajaya Guidelines and MSC Guidelines • Low-density housing • 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 • Fetilizer & pesticide use is controlled and monitored • Stream flow to be preserve • EIA study to be carry out	• Industry • Development with pollution - sediment from improperly managed construction sites and eroding stream banks. • more than 20% slope (accept recreations)
UNITEN	**INSTITUTIONAL**	**Activities**	**Conditions**	
Institutional Centre Total Area: 93.80 acre	• Hostels/Collage • Faculty • Administration Centre • R&D Centre • Open Space/Feild • Mosque • Library • Laboratory	• Housing/Quarters • Commercial • Food court • Pedestrian walk • Buffer Zone • Farms & Orchards • Lake/pond • Sewerage Treatment Plant • Golf Course • Public facilities • Sports Complex • Recreations • Road/Drainage • Highway/ERL	• Must follows Planning Standard Guidelines, Lake Catctment Guidelines, Putrajaya Guidelines and MSC Guidelines. • 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 • Fetilizer & pesticide use is controlled and monitored • Stream flow to be preserve • EIA study to be carry out	• Industry • Land earthwork clearing more than 15% of catchment • Development with pollution - excess fertilizers, herbicides, and insecticides from agricultural lands and parks - bacteria and nutrients from livestock, wildlife, pet wastes and sewerage system

TABLE 3.2 : LAKE CATCHMENT LANDUSE MASTERPLAN – USE CLASS ORDER (*cont'd)*

LAKE CATCHMENT AREA (PLOT)	PERMITTED USE	PERMITTED WITH CONDITION		NON PERMITTED USE
SUNGAI MERAB VILLAGE	**MIXED DEVELOPMENT**	**Activities**	**Conditions**	
Mixed Development Total Area: 89.60 acre	• Low Density Housing - Bungalow lots - Cluster - Semi Detached - Condominium/Apartments (40 upa) - Tarrace House (12 upa) • Neighbourhood Commercial - Local Shopping Centre • Enterprise Office • Research Centre/institution • Small/medium Enterprise related to IT • Institutional •	• Shopping Centre • Medical Centre • Food Stall • Institutional • Open Space & Recreation - Town Park - Community Open Space • Commercial - District Shopping Centre • Workshop • Light Industry • Public Facilities • Lake/pond • Sewerage Treatment Plant • Road/drainage	• Must follows Planning Standard, Lake Catctment Guidelines, Putrajaya Guidelines and MSC Guidelines • Low-density development • Structure which are complimentary to recreational activities and environmental • 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 • Fetilizer & pesticide use is controlled and monitored • Stream flow to be preserve • EIA study to be carry out	• Industry • Development with pollution - sediment from improperly managed construction sites and eroding stream banks. • more than 20% slope (accept recreations)

all drainage lines should terminate at detention ponds converted into mini-wetlands, where possible. The detention ponds shall be connected to the Lake through a vegetated landscape drainage corridor. GPTs shall be provided at all concrete drain outlets into the vegetated landscape drainage corridors.

3.6.1.3 Due to the positive benefits of mini wetlands on water quality it is recommended that all existing and proposed detention ponds be converted to mini wetlands, where possible. Figure 3.7 shows the locations of the recommended mini wetlands cum detention pond sites in the catchment. The typical profile and design schematic, respectively, of the mini wetlands cum detention ponds are shown in Figures 3.3 and 3.4, respectively.

See Vol-2, Section 2.9.2.3 Detention Ponds and Mini Wetlands

3.6.2 The Drainage Masterplan

3.6.2.1 The recommended improvements and changes to the drainage systems in the catchment areas outside Putrajaya, to integrate them to the Putrajaya drainage masterplan, are summarised below.

See Vol-2, Section 4.6 The Drainage Masterplan

3.6.2.2 **UPM**

(1) Figure 2.7A shows the recommended drainage system for the UPM area. It indicates that the existing streams in the UPM areas should be preserved and be provided with reserves on both sides for the vegetated landscape drainage corridors. Since 74% of the UPM areas (within the Lake catchment) are green areas it will not be too difficult for the UPM to comply with the recommendations.

(2) The drainage systems of the proposed ERL and SKVE are to be integrated to the existing streams in the area. In the integration process it is recommended that all existing streams in the UPM area that are affected by the proposed construction works are to be upgraded with the provision of vegetated landscape drainage buffer corridors and mini wetlands cum detention ponds, where pertinent. Also, the drainage system

connecting the ERL and SKVE to the vegetated landscape streams are to be provided with GPTs and sediment traps.

3.6.2.3 **MARDI**

(1) Figure 2.7B shows the recommended drainage system for the MARDI area. It indicates that the existing streams in the MARDI areas should be preserved and be provided with reserves on both sides for the vegetated landscape drainage corridors. Since 74% of the MARDI areas (within the Lake catchment) are green areas and MARDI's proposed development theme is in harmony with the wetland concept in Putrajaya there should not be any problem for MARDI to implement the recommended vegetated landscape drainage corridor concept.

(2) There is a need to integrate the proposed ERL and SKVE drainage systems into the existing drainage system, which eventually flows into the Upper West wetlands. *The situation is especially urgent since the land clearing and earthwork phase for the SKVE in the area has already started.*

(3) In the integration process it is recommended that all existing streams in the MARDI area that are affected by the proposed construction works are to be upgraded with the provision of vegetated landscape drainage buffer corridors and mini wetlands cum detention ponds, where pertinent. Also, the drainage system connecting the ERL and SKVE to the vegetated landscape streams are to be provided with GPTs and sediment traps.

3.6.2.4 **IOI**

(1) Figure 2.7C shows the recommended drainage system for the IOI area. It indicates that 3 of the proposed ponds in the area are to be converted to mini wetlands. Also, it is recommended that the drains connecting the 3 ponds to the Putrajaya wetlands are to be provided with vegetated landscape drainage corridors.

3.6.2.5 **West Country Berhad**

(1) Figure 2.7D shows the recommended drainage system for the West Country Bhd. area. The figure indicates that the proposed drainage system for the area comprises of an 18.3 acre (7.3 ha) flood detention and recreational lake, which is cut into two by the proposed Putrajaya-SKVE access road. The proposed main drains leading into and out of the lake are also shown in the figure.

(2) The proposed layout for the lake will most probably be revised because of the alignment of the proposed Putrajaya-SKVE access road. Thus, it is recommended that in the revision of the drainage layout, two or more smaller lakes/ponds be provided on either side of the Putrajaya-SKVE access road. The 2 lakes/ponds on either side of the access road are to be located on the existing stream in the area and a bridge crossing should be provided for the access road instead of a concrete culvert.

(3) The reason for the above recommendation is based on the environment-friendly drainage concept of "minimum disruption to the existing drainage system" so as to preserve and upgrade the existing stream network, as far as possible. Thus, the existing streams are to be upgraded through the provisions of vegetated landscape drainage corridors and mini wetlands cum detention ponds.

(4) It is recommended that the drainage consultant for West Country adopts the above concept and revised its proposed drainage layout to incorporate the vegetated landscape drainage corridors in its development. The last pond in the proposed drainage system, which connects to the Upper East wetlands, should be a mini wetland type pond. Also, the existing stream should be preserve and upgraded as the connecting drain between the last pond and the Upper East wetlands.

(5) All the concrete drains in the proposed revised drainage system leading into the upgraded existing streams should be provided with GPTs. To minimise maintenance the CDS-type GPT shown in Figure 3.5 maybe considered.

3.6.2.6 **Cyberjaya Flagship Zone**

(1) Figure 2.7E shows the recommended drainage system for the Cyberjaya area. The proposed drainage system by the Cyberjaya consultant is based on direct discharge of runoff into the Putrajaya Lake. To remove gross pollutants from the runoff GPTs have been provided at all the outlets. There are no provisions for detention ponds in the proposed drainage system, which is contrary to the DID guidelines, which requires that 5% of any proposed development area be reserved for detention ponds.

(2) To improve the quality of the runoff flowing into the Lake it is recommended that, wherever possible the drainage system should be based on vegetated landscape drainage corridors and conversion of flood detention ponds into mini-wetlands. Also, all drainage lines should terminate at detention ponds converted into mini-wetlands, where possible. The detention ponds shall be connected to the Lake through a vegetated landscape drainage corridor.

(3) Based on the above concept the following are the recommended drainage system for the Cyberjaya area:

(a) Conversion of part of the Lake into wetlands

It is recommended that, *if possible*, part of the two Lake bays within the Cyberjaya area be converted to wetlands by the construction of rock embankments across the two bays of the Lake as shown in Figure 2.7E. The wetland will serve to treat the water that flows into the lake and also retard the flow before it enters the lake. The rock embankments are recommended at the outfall of the wetlands to act as a weir and also to filter the flow. The final peak discharge from the wetlands into the lake will be much lower than that estimated by the drainage consultant of Cyberjaya.

The Consultant recognises that the above recommendation may not be acceptable with the Cyberjaya developer, who may prefer a clear Lake frontage. If that is the case, it is recommended that as much of the upstream drainage

system be designed based on the vegetated landscape drainage corridor cum mini wetlands detention pond system. Only the smallest downstream drainage areas should be allowed to drained directly into the Lake. Also, GPTs and sediment traps should be provided at the outlets into the Lake. The CDS-type GPT is recommended to be installed.

(b) Provision of detention ponds

It is recommended that detention ponds be provided at the two locations indicated in Figure 2.7E, where direct discharge of runoff into the Lake is proposed. The size of the detention pond is 1.1 and 3 ha. The 3 ha. detention pond can be divided into 2 ponds and are connected by a culvert running under a road. The detention ponds are recommended to be converted into mini-wetlands and the drains connecting them to the Lake should have vegetated landscape drainage corridors.

3.7 SEWERAGE PLANNING

3.7.1 Effluent Quality Standard

The Recommended Effluent Quality Standard that is applicable for the Putrajaya Lake catchment is given in Appendix 5. The Appendix also shows how the Standard compares with the followings standards:

(i) Interim National River Water Quality Standard for Malaysia - Class II B.
(ii) Putrajaya Ambient Lake Water Quality Standard
(iii) EQA Effluent Standard A

See Vol-2, Section 5.5 Sewage Effluent Quality Requirements

3.7.2 Sewerage Planning and Design Guidelines

3.7.2.1 The following are the pertinent points for the sewerage planning in relation to the Putrajaya Lake Catchment:

- Wherever possible and applicable, all treated sewage effluents from the developments in the catchment shall be channelled outside the Putrajaya Lake catchment.

- Where possible, treated effluents are to be directed into the Putrajaya Wetlands or detention ponds/mini wetlands, instead of direct discharge into the Putrajaya Lake.
- Where possible, treated effluents are to be discharged into drainage retention ponds, which shall act as a water dilution body and saturation pond for polishing the soluble organic wastes of the treated effluent.
- No industrial wastewaters are allowed to be discharged into the sewers and sewage treatment plants.

3.7.2.2 The sewerage design should include elements for emergency response measures, safety in the plant layout and process designs, power supply arrangements, standby units and back-up capacity for plant processes, emergency uses of portable pumps, and treatment process controls.

3.7.2.3 The recommended sewage treatment practices (processes) are biological nitrification/de-nitrification to remove nitrogen, followed by the addition of alum to remove phosphorus and chlorination to remove and control pathogenic organisms in the effluent.

3.7.2.4 General guidelines for Emergency Response Planning (ERP) covering (i) emergency preparedness (planning), (ii) mitigation, (iii) response and (iv) recovery are also presented.

See Vol-2, Section 5.6 Sewerage Planning and Design Guidelines

3.7.3 The sewerage masterplan

3.7.3.1 Table 3.3 shows the sewerage discharge loadings in the form of Population Equivalent (PE) for the existing and future land-use in the catchment and the locations for their effluent discharges.

3.7.3.2 The following are the recommendations for the 4 areas with sewage effluent discharges flowing into the Lake.

See Vol-2, Section 5.7 Sewerage Masterplan for Putrajaya Lake Catchment

3.7.3.3 **MARDI**

(1) It is recommended that the existing sewage flows of 600 PE and sewage flows from the future developments in MARDI are to be connected to a proposed new central sewage treatment plant.

(2) The proposed plant is expected to cater for the combined sewage treatment requirements for the MARDI and UPM developments lying within the lake catchment. The sewerage plan will have to be developed when the future land-use of MARDI and UPM are available.

3.7.3.4 **UPM**

(1) The sewage treatments for the wastewater from Kolej 8 (1,097 PE) and Kolej 9 (1,038 PE) are unsatisfactory. The existing sewage treatment plants for the two hostels should be upgraded.

(2) The sewage flows from the two hostels, together with those from the Pusat Kesihatan Pelajar, Kafe, UPM-MTDC and future developments, including the from the proposed teaching hospital, are to be sewered to a proposed new and central sewage treatment plant located upstream of the UPM ponds and the Upper North Wetland.

(3) The proposed central sewage treatment plant could also treat the sewage flows from MARDI.

(4) The proposed UPM-MARDI central sewerage treatment plant can be integrated into the Indah Water Konsortium (IWK) sewerage development plan for the Kota Perdana/ Listari sewerage sub-catchment in the Petaling district. The treated effluent at the proposed UPM-MARDI central treatment plant shall be transferred outside the lake catchment

3.7.3.5 **IOI**

(1) The present proposed sewer reticulation and a central sewage treatment plant of capacity 7,761 PE, which is under construction, has been approved by Jabatan Perkhidmatan Pembentungan (JPP).

Table 3.3 Existing And Proposed Landuses And Population Equivalent (PE)

	DEVELOPMENT	LANDUSES		ESTIMATED PE					REMARKS
		Existing	Proposed	Existing	Proposed	Total	Other River	Sg Chuau	
1	Putrajaya	Phase 1 Federal Administration City Development	Phase 2 Federal Administration City Development	100,000	500,000	600,000	100,000+ 500,000*		+ Sg Air Hitam *Downstream of Sg Chuau Phase 1 Development in progress
2	Cyberjaya Flagship Zone	MDC Head Office, Cyber Lodge, Site Offices, Service Apartments	Phase 1B – Country Heights Low Density Residential Development (27 ha)	1160*	560	1,720	-	1,720	*Temporary Discharges
3	Universiti Putra Malaysia	Kolej 8 Kolej 9 Kolej Matimulation Pusat Kesihatan Pelajar Kafe UPM-MTDC (Research Centre) Time Telekom	Kolej Baru*	1,097 1,038 2,000 25 50 150 5	7,000				*Kolej Baru is under construction Expected completion year 2000/2001 Only landuses in the catchment are included

	DEVELOPMENT	LANDUSES		ESTIMATED PE					REMARKS
		Existing	Proposed	Existing	Proposed	Total	Other River	Sg Chuau	
		UPM Golf Club Infor Post		360 200					
				4925	7000	11,925	-	11,925	
4	MARDI	Pejabat-pejabat Quarters		500 100		500 100			
				600		600	-	600	
5	Palm Garden Resort Development	Club-house Service Apartments Office Development* Condominium*	Future Office Development Future Hotel	300 612 1255 1920	1394 2280				* Under Construction Expected Completion Year 2000
				4087	3674	7761		7761	
6	TNB Serdang Power Station	Existing Power Plant with 50 operation staff		50	-	50	50+		+Sg Gajah
7	West Country Development	-	Residential and Commercial Development*		16,090	16,090	16,090+		• Preliminary Planning Stage + Sg. Air Hitam
				110,822	527,324	638,146	616,140	22,006	

(2) It is recommended that the water quality of the combined discharge of surface runoff and the treated effluent at the outfall of the retention pond be monitored.

(3) In the event that the sewage is inadequately treated and does not meet the Recommended Effluent Standard, the sewage treatment plant is to be upgraded with supplementary processes for the nutrients (TN and TP) removal. This would involve provision of anoxic tank and introduction of alum for the denitrification of TN removal and chemical precipitation of phosphorous removal, respectively.

3.7.3.6 **Cyberjaya Flagship Development Zone (Phase 1B)**

(1) The sewage flows from the Phase 1B Cyberjaya Flagship Zone that lies within the lake catchment, will eventually be transferred outside the catchment in accordance with its overall sewerage development plan. The treated effluents will not therefore be discharged into the lake body.

(2) However, there are four existing temporary sewage treatment plants of total capacity of 1,160 PE in the Phase-1B Development area and the treated effluents are discharging into the open drains that lead to the Phase-2 Lake, i.e. downstream of the temporary dam. Presently, there is no impact because the Phase-2 Lake is not constructed yet.

(3) It is recommended that, when the Phase-2 Lake is formed, the treated effluents from the existing temporary sewage treatment plants shall be collected and transferred outside the lake catchment.

(4) The proposed Cyberjaya Sewerage Development Plan and strategy shall be implemented to ensure that the sewage flow in Phase-1B Cyberjaya Flagship Zone is not discharged into the Phase 2 Putrajaya Lake, which is scheduled to be completed and commissioned by 2001.

3.8 PLANNING AND LAND-USE CONTROL

The following recommendations are pertinent to the planning and land-use control:

- To develop and gazette local plans for the areas outside Putrajaya. The JPBD is currently doing this for the area (see Section 3.5.2 above).
- To implement similar planning submission and approval process requirements as that in the Perbadanan, for all proposed development projects in the catchment areas of the Majlis Daerah Sepang (MDS).
- To assign an additional Planner and Technical Assistant to the MDS to cope with the increase workload due to the additional work arising from the implementation of the detailed planning submission requirements above.

3.9 DRAINAGE MANAGEMENT AND CONTROL

The following recommendations are pertinent to drainage management and control:

- To require all development projects, including utilities and transportation projects to comply with the recommended drainage concept and design guidelines for the Putrajaya Lake catchment, as described in Section 3.6.1 above.
- To assign an additional Civil Engineer and Technical Assistant to the MDS so that they can give special attention to drainage and earthworks for developments in the Putrajaya Lake catchment areas.

3.10 ENVIRONMENTAL MANAGEMENT AND POLLUTION CONTROL

The following recommendations are pertinent to environmental management and pollution control:

- To implement the requirements of the Putrajaya Environmental Management Guide for all development projects in the Putrajaya Lake catchment.

- To ensure integrated management of the Lake waterfront environment it is recommended that the 20-metre green zone buffer along the Lake in the Cyberjaya area be given over to the Perbadanan Putrajaya to manage.

- To create an Environmental Unit (EU) within the MDS set-up, by assigning an Environmental Officer and a Technical Assistant to the Unit. The Unit will be responsible for discharging all the environmental regulatory responsibility of the EU specified in the Guide, for development projects in the MDS area.

3.11 COORDINATION BETWEEN REGULATORY AGENCIES

3.11.1 Formation of a Management Committee under the SWMAE

3.11.1.1 The legislative review carried out recommended that the Putrajaya Lake catchment be classified as a designated sub-catchment for water source protection under the Selangor Waters Management Authority Enactment (SWMAE). The SWMAE is the most appropriate legal vehicle for integrated catchment management.

See Vol-2, Section 8.1.7 Recommendations

3.11.1.2 Article 46(1) (d) of the SWMAE allows the SWMA to establish local area management committees and stakeholders groups to work with the SWMA in the management of a designated water source or sub-catchment. Thus, it is recommended that a Management Committee be formed to work with the Selangor Waters Management Board to manage the catchment.

See Vol-2, Section 8.2.5 Proposed Institutional Arrangements for Administration

Article 46 (SWMAE) - Implementation of integrated management plans

"(1) Notwithstanding anything to the contrary contained in any written law, the Authority -

(a) ……

(d) may establish local area management committees and stakeholder groups to work with the Authority;"

3.11.1.3 The proposed structure for the management of the Lake catchment is shown in Figure 3.8.

3.11.2 The Management Committee

3.11.2.1 It is recommended that the members of the Committee be made up of representatives from the following: (cannot exceed 12 members):

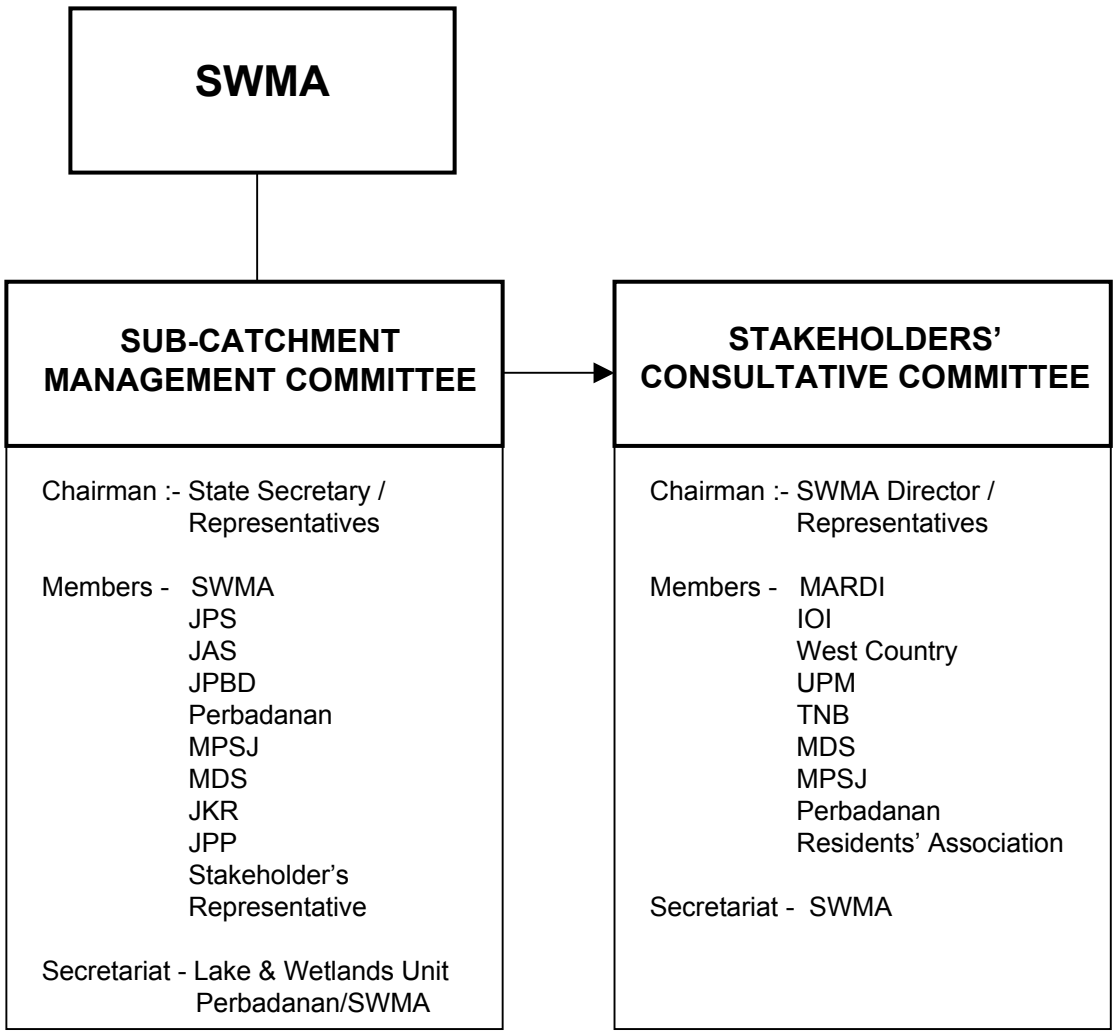
Chairman: State Secretary/Representative

Members:
1. Drainage and Irrigation Department
2. Department of Environment
3. Town and Country Planning Department
4. Perbadanan Putrajaya
5. Majlis Perbandaran Subang Jaya
6. Majlis Daerah Sepang
7. Jabatan Kerja Raya
8. Sewerage Services Department
9. Representative of Stakeholder's Consultative Committee

Secretariat: SWMA/Perbadanan Putrajaya's Lake & Wetlands Unit

Since the Committee is a sub-committee of the SWMA Technical Committee, chaired by the State Secretary, it is recommended that the Chairman of the Committee should be the State Secretary or his representative.

FIGURE 3.7: PROPOSED STRUCTURE FOR PUTRAJAYA LAKE CATCHMENT MANAGEMENT



3.11.2.2 The Perbadanan has the greatest stake in preserving the water quality in the Lake and has all the necessary resources to manage the Putrajaya Area to meet the desired water quality objectives of the Lake. Thus, it is recommended that the functions of the Committee be confined to the following main issues related to integrated management of the catchment*, for the areas outside Putrajaya*.

- Provide advise relating to land use planning and management in the areas, that are necessary for integrated management of the catchment;
- Provide advise relating to drainage control and management;
- Provide advise relating to pollution control and management;
- Provide advise on the monitoring programme required for the integrated management of the catchment;
- Provide advise on the enforcement action required to be taken; and
- Provide advise on the works required to support the integrated management of the catchment.

A draft TOR for the Committee has been drawn-up (*see Appendix 6*). The Committee has to be formalised by the SWMA eventually.

3.11.2.3 With the above institutional arrangements the micro-management of the catchment areas within Putrajaya will be the responsibility of the Perbadanan, whereas those outside will be the responsibility of the SWMA. *However, from the macro-management perspective of the Langat River Basin, the Perbadanan still has to meet the water quantity and quality requirement, downstream of the Putrajaya Lake catchment, set by the SWMA*.

3.11.3 Monitoring Functions to be delegated to Perbadanan

3.11.3.1 The SWMAE allows the SWMA to work with and also delegate its catchment management functions to any existing

authority that has been carrying out such functions in the designated area before its designation.

3.11.3.2 Since the Perbadanan has developed a number of pertinent guidelines (Environmental Management Guide, Lake Management Guide, Stormwater Design Guidelines) that are important for the management of the catchment for 70% of the catchment area and is already carrying out the monitoring for the Lake, it is logical for the SWMA to delegate the monitoring functions of the Lake to the Perbadanan.

3.11.3.3 Also, the SWMA can adopt the pertinent Guidelines and make it legally applicable for the developments in the areas outside Putrajaya. (There will be a need to revised the Environmental Management Guide to incorporate the role of the Management Committee relative to the Environmental Units in the Perbadanan and the MDS, if it is adopted).

3.11.4 Formation of Stakeholder's Consultative Committee

3.11.4.1 The SWMAE also allows the SWMA to create Catchment Stakeholders' Group to encourage catchment community participation in catchment management. Thus, it is recommended that a Stakeholder's Consultative Committee be formed, comprising representatives from the major stakeholders in the catchment and from Residents' Association. A draft TOR for the Committee has been drawn-up (*see Appendix 7*).

3.12 MONITORING AND REVIEW

3.12.1 The following items necessary to facilitate the monitoring and review exercise on the effectiveness of the implementation of the Plan are recommended:

- Setting-up a hydrological monitoring network
- Setting-up a water quality monitoring network
- Implementing the low-level ICMS

3.12.2 Hydrological Monitoring Network

(1) The hydrologist has proposed that a hydrological monitoring station network be installed to support the management of the Putrajaya Lake, upon the implementation of the Lake Catchment Management Plan.

(2) A total of 5 automatic rainfall measuring stations, 7 automatic streamflow gauging stations and 5 automatic water level measuring stations have been proposed. The locations of the stations are shown in Figure 3.9.

3.12.3 Water Quality Monitoring Network

(1) The water quality specialist has proposed that a *Water Quality Monitoring Program* be implemented, over a 3-year period, upon the implementation of the Lake Catchment Management Plan.

(2) The details of the Program are given in the *Putrajaya Lake Management Guide.* A total of 81 water level recorders and 23 water gauging stations have been proposed to be installed over the 3-year period.

3.12.4 Implementation of the low-level ICMS

(1) To support the management of the large amount of monitoring data collected, such as hydrological data, water quality data, information on the health of the flora and fauna in the wetlands, etc., a *low-level Integrated Catchment Management System (ICMS)* has been developed as part of this study.

(See Chapter 7 in Volume 2 of this Report)

(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 3.10 below. They are:

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

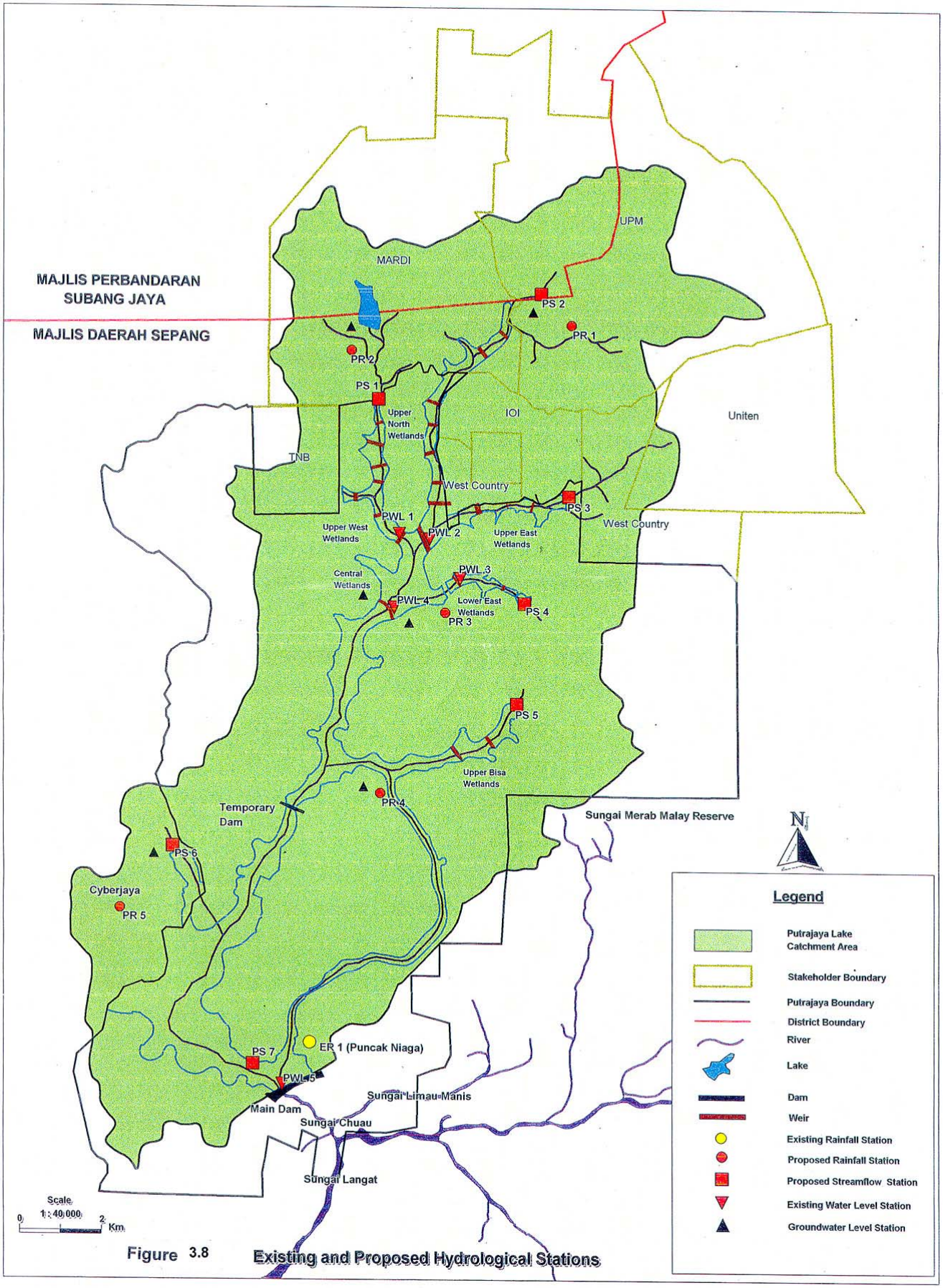


Figure 3.8 Existing and Proposed Hydrological Stations

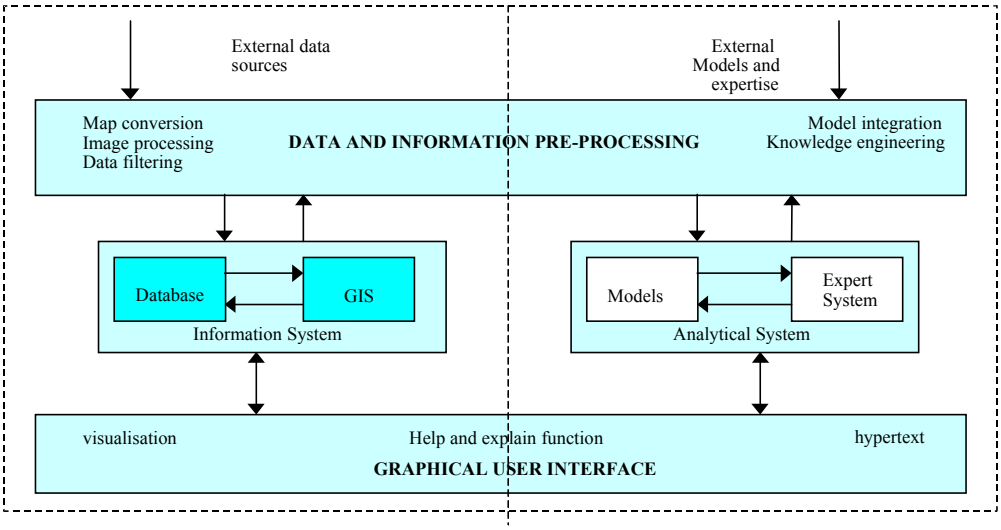


Figure 3.10 The Complete ICMS

(3) The focus of the low-level ICMS is on managing geographical map information using the computer and on managing the monitoring data collected by means of a computer database.

(4) The low-level ICMS is highly scalable and can be developed into a complete ICMS, as part of Perbadanan Putrajaya's Sumber Putra IT System, in multiple stages according to the automation and analytical needs of the Perbadanan Putrajaya.

(5) The Perbadanan Putrajaya is recommended to install and use the low-level ICMS on a stand-alone computer for a period of 6 months before making a decision on further development and refinement of the low-level ICMS.

(6) To facilitate the installation, training and use of the low-level ICMS it is recommended that the Perbadanan Putrajaya purchase a copy of the Arc View GIS software and a computer, as soon as possible.

CHAPTER 4
CATCHMENT MANAGEMENT SYSTEM

4.0 CATCHMENT MANAGEMENT SYSTEM

4.1 INTRODUCTION

4.1.1 To facilitate the implementation of the Plan developed in Chapter 3 there is a need for a Catchment Management System. The Consultant is proposing the following 10 elements as the basis for the System:

1. Catchment Management Policy
2. Catchment Management Issues
3. Legal and Other Requirements
4. Catchment Management Objectives and Targets
5. Catchment Management Programs
6. Catchment Management Institutional Structure
7. Catchment Community/Stakeholder Participation
8. Awareness and Training Requirements
9. Emergency Preparedness and Response
10. Monitoring and Review

4.2 CATCHMENT MANAGEMENT POLICY

This element describes:

- the desired vision for Putrajaya Lake and its Catchment
- the reason why it is important to manage the Catchment
- the Catchment management policy statement

4.2.1 The Vision for Putrajaya Lake and its Catchment

4.2.1.1 Putrajaya and its Lake catchment (see Figure 1.2) is envisaged to be developed into a "City in a Garden" with the 552 hectares Putrajaya Lake as its focal point. (See Figure 4.1 and 4.2)

Figure 4.1 The "City in a Garden" Vision for Putrajaya

Figure 4.2 Realising the Vision - The Putrajaya Mosque

4.2.1.2 To perform its intended functions, of catering to the multi-functional uses of the catchment community and its surroundings, the Lake has to be always in pristine condition, with a high water quality. It will be used for recreation, boating,

fishing and water transport, in addition to enhancing the aesthetics of the landscape in the catchment.

4.2.1.3 The built and natural environment in the catchment shall be integrated to create a living environment for the catchment community that will promote an active, lively and caring society, and also ease the pressure and stress of modern living.

4.2.2 Why is it important to manage the Catchment ?

4.2.2.1 The Government is concerned about the water quality in the Lake. The vision of a "City in a Garden" for Putrajaya and its Lake catchment cannot be attained without a high water quality for the Lake.

4.2.2.2 Being a man-made lake the Government recognises that careful planning and management of the physical as well as the human issues related to the Lake catchment is necessary. One of the major issue is the control of development activities in the catchment.

4.2.3 Catchment Management Policy Statement

4.2.3.1 Recognising the importance of careful planning and management for the attainment of the vision for Putrajaya and its Lake catchment the following *draft* policy statements have been prepared for comments and agreement by the Lake Catchment Management Committee.

4.2.3.2 The Putrajaya Lake Catchment shall be managed based upon the following policies:

- Pollution control measures shall be focussed on the minimisation of pollutant generation at source.
- The Putrajaya wetlands shall be considered as an *additional (last stage)* water quality enhancement or "polishing" mechanism. It shall be integrated with upstream water quality enhancement features, such as vegetated landscape riparian buffers, drainage corridors and upstream mini-wetlands cum flood detention ponds.
- The drainage system shall be based on vegetated landscape drainage corridors and conversion of flood detention and water quality enhancement ponds into mini-wetlands.

- All treated sewage effluents from any new development in the catchment shall be channelled outside the Putrajaya Lake catchment.
- No diversion or alteration of the natural drainage lines in the catchment is allowed.
- All development activities in the catchment shall be in accordance with the approved Catchment Development Land-use Master Plan.
- All pertinent regulatory agencies shall co-ordinate their functions to ensure the integrated management of the catchment.
- All legal and other requirements shall be enforced to attain the catchment management objectives and targets.
- Active participation of the catchment community in the management of Putrajaya Lake are to be encouraged.
- Equitable sharing of the cost for the implementation of the catchment management programs.
- Maintenance cost shall be recovered based on the policy of *"the polluter pays"* and *"the direct beneficiaries pays"*

4.3 CATCHMENT MANAGEMENT ISSUES

4.3.1 This element describes the catchment management issues that have been identified to be important for the attainment of the vision for Putrajaya Lake. The issues are:

1. Pollutant-carrying capacity of the Lake
2. Effectiveness of the Wetlands
3. Point and non-point pollutants sources management
4. Water quantity management
5. Land-use planning
6. Drainage planning
7. Sewerage planning
8. Planning and land-use control
9. Drainage management and control
10. Environmental management and pollution control
11. Co-ordination between regulatory agencies
12. Monitoring and Review

4.3.2 Brief discussions on each of the above issues are given in Chapter 2.0 and the associated recommendations are given in Chapter 3.0.

4.4 LEGAL AND OTHER REQUIREMENTS

This element provides a list of the various legislation and guidelines that are applicable to the management of the Catchment.

4.4.1 Legislation

The following are the pertinent legislation relevant to the management of the catchment:

1. Waters Act, 1920
2. Geological Survey Act, 1974
3. Irrigation Areas Act, 1953
4. Street, Drainage and Building Act, 1974
5. The Forest Act, 1984
6. The National Land Code, 1965
7. The Drainage Works Act, 1954
8. The Fisheries Act, 1985
9. Environmental Quality Act, 1974
10. Land Conservation Act, 1960
11. Town and Country Planning Act, 1976
12. Local Government Act, 1976
13. Selangor Waters Management Authority Enactment, 1999
14. Mining Enactment, 1929
15. Sewerage Services Act, 1993

Municipal Rules

1. Planning Control (General) Rules
2. Earthworks By-Laws
3. Stray Animal By-laws
4. Licensing of Trades, Businesses and Industries By-laws
5. Refuse Collection, Removal and Disposal By-Laws
6. The Public Cleansing By-Laws
7. Anti-Litter By-laws
8. Parks By-laws

4.4.2 Guidelines

The following are the pertinent guidelines relevant to the management of the catchment:

- Putrajaya Masterplan and Urban Design Guidelines
- Putrajaya Lake Management Guide
- Putrajaya Environmental Management Guide
- Putrajaya Stormwater Management Design Guide
- DOE Guidelines for prevention and control of soil erosion and siltation in Malaysia
- New JPS Drainage Design Manual (to be published in 2000) based on source-control concept.
- All pertinent guidelines of JPBD
- All pertinent guidelines of JPS
- All pertinent guidelines of JPP

4.5 CATCHMENT MANAGEMENT OBJECTIVES AND TARGETS

4.5.1 This element highlights the catchment management objective and the list of targets to be achieved over a defined time period.

4.5.2 The primary catchment management objective is to attain the Putrajaya Lake Ambient Water Quality Standard, as given in Appendix 2.

4.5.3 The list of targets to be achieved has to be prepared and agreed upon by the Lake Catchment Management Committee. The targets will define the reduction in values of the pertinent measurable parameters defining the desired Lake Ambient Water Quality Standard, over an agreed monitoring period, relative to the current baseline condition.

4.6 CATCHMENT MANAGEMENT PROGRAMS

4.6.1 This element list and describes the catchment management programs to achieve the catchment management objective and targets highlighted above.

4.6.2 The exact management programs to address each of the target reduction in water quality parameter values will be determined by the Catchment Management Committee.

4.6.3 As a first step in setting the stage for a system of continuous improvement towards attaining the desired water quality objective, the recommendations associated with the 12 catchment management issues highlighted in Section 4.3 above should be implemented. The recommendations are discussed in Chapter 3.0.

4.7 CATCHMENT MANAGEMENT INSTITUTIONAL STRUCTURE

This element describes the proposed institutional structure for the management of the Catchment. They have been described in Section 3.11 of this Volume. Further details are given in Section 8.2.5 of Volume 2 of this Report.

4.8 CATCHMENT COMMUNITY/STAKEHOLDER PARTICIPATION

4.8.1 This element provides a list of the possible programs to engage the catchment community/stakeholder in participating actively in the management of the Catchment.

4.8.2 The following are some possible programs that can be promoted. The details of each program have to be developed and implemented by the Lake Catchment Management Committee.

(a) To implement a program to increase the awareness of the stakeholders on the benefits to them of attaining the desired water quality objective for the Lake and what they can do to help attain the objective.
(b) To implement a program of "neighbourhood adoption" of part of the Lake and vegetated landscape drainage corridor frontage, by emphasising the benefits to the stakeholders of participating in the program.
(c) To implement programs to promote nature appreciation activities like bird watching, nature walks, etc associated with the Lake, wetlands and the green vegetated landscape drainage corridors in the catchment.
(d) To implement programs to encourage school and university students to conduct research on the many different aspects related to the Lake and wetlands management.

4.9 AWARENESS AND TRAINING REQUIREMENTS

4.9.1 This element identifies and list the awareness and training requirements for the various implementing agencies and authorities in the Catchment. It may also includes the important stakeholders in the catchment, such as the developers, consultant and contractors.

4.9.2 The following are some possible training and awareness programs that should be carried out.

(a) To conduct a seminar and workshop on the Putrajaya Environmental Management Guide for all pertinent regulatory officers, developers, consultants and contractors. The objective of the seminar is to introduce to the participants the requirements of the Guide and help them learn how to comply with its requirements.

(b) To conduct a seminar for the developers, consultants and contractors in the catchment to inform them on the desired drainage design concept, guidelines and best management practices for soil erosion control and management.

4.10 EMERGENCY PREPAREDNESS AND RESPONSE

4.10.1 This element provides a list of the emergency preparedness and response requirements related to the impacts on Putrajaya Lake.

4.10.2 There is a need to ensure that emergency preparedness and response plans are prepared to address the possible emergencies. The following are some possible emergencies that have been highlighted in the study.

- Oil or chemical spillage due to accidents along the road crossing the Putrajaya Wetlands.
- Failure of the sewage treatment plants in MARDI/UPM and IOI.

4.11 MONITORING AND REVIEW

This element provides a list of the monitoring programs required to support the Lake Catchment Management Committee in its review on the effectiveness of its programs in attaining the desired water quality objective and targets.

The following are the recommended monitoring requirements:

- Water quality monitoring
- Sewage effluent discharge monitoring

4.11.1 Water Quality Monitoring

The details related to the water quality monitoring requirements are described in the Putrajaya Lake Management Guide.

4.11.2 Sewage Effluent Discharge Monitoring

The proposed locations for the sewage effluent monitoring in the catchment are given in Table 4.1 below. Details on the programme are given in Section 5.8 Effluent Quality Monitoring Programme in Volume 2 of this Report.

Table 4.1 Proposed locations of sewage effluent monitoring stations

Stakeholders	No. of locations	Location
MARDI	4 locations:	One each at the effluent outlet of the four existing septic tanks
UPM	6 locations:	Effluent outlets at Imhoff tank of Kolej 8, at two septic tanks of Kolej 9, at packaged plant of Kolej Matrikulasi and two discharge points of streams into Putrajaya Upper North Wetland.
IOI Palm Garden	1 location	At the combined flow outfall of retention pond
Cyberjaya Flagship Zone (Phase 1B)	4 locations:	One each at the effluent outlets of four existing temporary sewage treatment plants
Total	15	

CHAPTER 5
IMPLEMENTATION SCHEDULE AND BUDGET

5.0 IMPLEMENTATION SCHEDULE AND BUDGET

5.1 INDICATIVE COSTS ESTIMATES

Indicative cost estimates for the recommended programs associated with the following study components have been prepared:

- Water quality
- Hydro-geology
- Hydrology
- Drainage
- Sewerage
- ICMS
- Institutional

5.1.1 Water Quality Study

5.1.1.1 The water quality specialist has proposed a ***Water Quality Monitoring Program*** to be implemented, over a 3-year period, upon the implementation of the Lake Catchment Management Plan.

5.1.1.2 Table 5.1 gives the summary of the indicative Capital, Operations & Maintenance (O & M) and water quality sampling costs associated with the Water Quality Monitoring Program over the 3-year period. The details are given in Appendix 9.1 of Volume 2 of this Report.

Table 5.1 Indicative costs associated with the Water Quality Monitoring Program for a 3-year period.

Period	Year-1 (RM)	Year-2 (RM)	Year-3 (RM)	Total (RM)
Capital	335,000	425,000	335,000	1,095,000
O & M	5,000	15,000	20,000	40,000
Sampling	725,000	1,815,000	2,426,400	4,986,400

5.1.2 Hydro-geological Study

5.1.2.1 The hydro-geologist has indicated that a groundwater well field of 6 wells can be developed, downstream of the main dam. The timing for the construction of the well field depends on the needs of Putrajaya for the groundwater.

5.1.2.2 The indicative capital and annual O & M costs associated with the development and operations of the groundwater well field are given below. The details are given in Appendix 9.2 of Volume 2 of this Report.

- Capital cost – RM144,000
- O& M cost – RM16,433/year

5.1.3 Hydrological Study

5.1.3.1 The hydrologist has proposed that a hydrological monitoring station network be installed to support the management of the Putrajaya Lake, upon the implementation of the Lake Catchment Management Plan.

5.1.3.2 The indicative capital and annual O & M costs associated with the setting-up and operations of the hydrological monitoring station network are given below. The details are given in Appendix 9.3 of Volume 2 of this Report.

- Capital cost – RM881,000
- O& M cost – RM69,000/year

5.1.4 Drainage Masterplan Study

5.1.4.1 The drainage engineer has proposed that mini-wetlands and vegetated landscape drainage corridors be constructed as part of the drainage system improvement in the areas outside Putrajaya.

5.1.4.2 Table 5.2 gives the indicative capital and annual O & M costs associated with the drainage system improvement works for the areas outside Putrajaya, together with pertinent remarks on their respective implementation schedule. The details are given in Appendix 9.4 of Volume 2 of this Report.

Table 5.2 Indicative costs associated with the drainage system improvement works in the areas outside Putrajaya.

Stakeholder Area	Capital Cost	Annual O&M cost	Remarks on implementation schedule
1. MARDI - Drainage corridor improvement (6.9 km)	RM8,942,400	RM56,000	To be implemented as part of the SKVE, ERL and MARDI's development in the area
2. UPM - Drainage corridor improvement (6 km)	RM7,776,000	RM60,000	To be implemented as part of UPM's development
3. IOI - 3 Nos. mini-wetlands	RM72,000	RM14,400	To be implemented as part of the development for the proposed ponds.
4. West Country - 1 No. mini-wetland	RM31,500	RM6,300	To be implemented as part of West Country's development
5. Cyberjaya - 6 water quality enhancement ponds provided with GPTs	RM81,000	RM16,200	To be implemented as part of Cyberjaya's development
Total	**RM16,902,900**	**RM152,900**	

5.1.5 Sewerage Masterplan Study

5.1.5.1 The sewerage engineer has proposed that a sewage effluent discharge monitoring program be implemented, upon the implementation of the Lake Management Plan. He has also proposed that the existing sewerage treatment plants for two student hostels in UPM, Kolej 8 (1097 PE) and Kolej 9 (1038 PE), be upgraded as soon as possible.

5.1.5.2 The indicative cost for the upgrading works for the two student hostels in UPM is **RM854,000** at RM400/PE.

5.1.5.3 The indicative annual operational costs associated with the operations of the sewage effluent discharge monitoring program, for the following 4 stakeholders, are given below. The details are given in Appendix 9.5 of Volume 2 of this Report.

- UPM – RM55,800/year
- MARDI – RM37,200/year
- IOI – RM9,300/year
- Cyberjaya – RM37,200/year

Total: RM139,500/year

5.1.6 ICMS Study

5.1.6.1 The ICMS team has recommended the purchase of a GIS program and a personal computer for the installation and training in the use of the low-level ICMS, developed as part of this study, *upon the completion of the study.*

5.1.6.2 The team also recommended that a decision be made*, after a trial period of 6 months*, on further work to refine, convert and integrate the low-level ICMS to the Perbadanan Putrajaya's SiCAD GIS.

5.1.6.3 The indicative cost associated with the above two recommendations are as follows:

(a) Installation and Training in the use of low-level ICMS

- GIS program (ArcView) – RM11,500
- Personal Computer – RM 9,000

Total RM20,500

(b) Refinement and conversion to SiCAD GIS

- Consulting cost – **RM200,000**
  (see Appendix 9.6 in Volume 2 of this Report for details)

5.1.7 Institutional Study

5.1.7.1 The institutional specialist has recommended the recruitment of an additional six staff for the Majlis Daerah Sepang (MDS), as part of the institutional strengthening exercise, upon the implementation of the Lake Catchment Management Plan.

5.1.7.2 He has also indicated that there are expenses associated with the holding of meetings of the Lake Catchment Management Committee and Stakeholders' Consultative Committee.

5.1.7.3 The indicative costs associated with the above two items are as follows. The details are given in Appendix 9.7 of Volume 2 of this Report..

- Staff recruitment for the MDS – RM141,000/year
- Meeting expenses – RM 26,000/year

Total RM167,000/year

5.2 INDICATIVE IMPLEMENTATION SCHEDULE AND BUDGET

5.2.1 Table 5.3 gives the indicative implementation schedule and budget for the various programs recommended by the respective specialists for an implementation period of 3 years.

5.2.2 From Table 5.3 it can be seen that the total indicative 3-year total cost of the recommended programs is about *RM 26.6 million*, made up of about *RM20.3 million for capital expenditure* and about *RM6.3 million for O&M expenditure*.

5.2.3 The bulk of the capital expenditure, about 83%, is for *drainage improvement which cost about RM16.9 million*. Also, the bulk of the O&M expenditure, about 81%, comes from the water quality sampling costs over the 3-year period.

5.2.4 The following programs are recommended to be implemented in the first year upon approval of the Lake Catchment Management Plan:

PUTRAJAYA LAKE CATCHMENT DEVELOPMENT AND MANAGEMENT PLAN

	CAPITAL COSTS (RM)					O & M COSTS (RM)					REMARKS
PROGRAMS	**Year 1**	**Year 2**	**Year 3**	**Unscheduled**	**Total**	**Year 1**	**Year 2**	**Year 3**	**Unscheduled**	**Total**	
1. Water Quality Monitoring Network	335,000	425,000	335,000		**1,095,000**	725,000	1,815,000	2,446,400		**4,986,400**	O & M Cost includes
(Refer App. 9.1 for details)											sampling costs
2. Development of groundwater well field				144,000	**144,000**				16,433	**16,433**	To be implemented
(Refer App. 9.2 for details)											when needed
3. Hydrological Monitoring Network	881,000	0	0	881,000	**881,000**	69,000	69,000	69,000		**207,000**	
(Refer App.9.3 for details)											
4. Drainage Improvement Cost											To be implemented
(a) MARDI				8,942,400	8,942,000				56,000	56,000	as part of each
(b) UPM				7,776,000	7,776,000				60,000	60,000	stakeholder's
(c) IOI				72,000	72,000				14,400	14,400	development program
(d) West Country				31,500	31,500				6,300	6,300	
(e) Cyberjaya				81,000	81,000				16,200	**152,900**	
(Refer App. 9.4 for details)					**16,902,900**						
5. Sewerage Improvement/Monitoring Cost											
(a) UPM	854,000				854,000	55,800	55,800	55,800		167,400	
(b) MARDI	240,000				240,000	37,200	37,200	37,200		111,600	
(c) IOI	0				0	9,300	9,300	9,300		27,900	
(d) Cyberjaya	0				0	37,200	37,200	37,200		111,600	
(Refer App. 9.5 for details)					**1,094,000**	139,500	139,500	139,500		**418,500**	
6. ICMS Installation and Improvement	20,500	200,000			**220,500**						
(Refer App. 9.6 for details)											
7. Institutional Strengthening (manpower)						167,000	167,000	167,000		**501,000**	
(Refer App. 9.7 for details)											
TOTAL COSTS	**2,330,500**	**625,000**	**335,000**	**17,927,900**	**20,337,400**	**1,100,500**	**2,190,500**	**2,821,900**	**169,333**	**6,282,233**	

- Water quality monitoring network
- Hydrological monitoring network
- Sewerage effluent discharge monitoring
- Sewerage improvement at UPM
- ICMS Installation
- Institutional Strengthening (additional manpower for MDS)

5.2.5 The total indicative capital expenditure in the first year is about *RM2,330,500* and that for O&M expenditure is about *RM1,100,500*.

5.2.6 74.5% of the capital expenditure in the first year, i.e. RM1,735,000, has been estimated for the upgrading of the sewerage treatment facilities for the two student hostels in UPM (RM854,000) and for the hydrological monitoring network (RM881,000). 69% of the O&M expenditure in the first year, i.e. RM725,000, is for the cost of the water quality sampling.

5.3 FUNDING

5.3.1 Funding Sources

5.3.1.1 The three main sources of funding for the successful implementation of the Consultant's recommendations are:

- The Federal Government
- The Selangor State Government
- The individual stakeholders

5.3.1.2 The Federal Government, through Perbadanan Putrajaya as the main stakeholder in the catchment, will have to bear most of the cost associated with the implementation of the recommended programs within the 70% of the catchment where Putrajaya lies.

5.3.1.3 The Selangor State Government, through its respective agencies and local authorities, will have to bear additional costs arising from increased regulatory supervision and maintenance in the 30% of the Lake catchment area that lies within the State, to meet the desired environmental objectives for the catchment.

5.3.1.4 The individual stakeholders in the catchment will have to bear additional costs as a result of complying with the additional

regulatory requirements imposed in the catchment to meet the desired environmental objectives for the catchment.

5.3.2 Funding Principles

5.3.2.1 The Federal Government, as the main project proponent for the development of Putrajaya, and the primary beneficiary from the development will most probably have to bear all the additional costs arising from the implementation of the recommended programs in the Lake Catchment Management Plan, that would not normally have been expended by the Selangor State Government and the individual stakeholders under normal circumstances.

5.3.2.2 However, the Selangor State Government and the individual stakeholders also benefit from the development of Putrajaya, through increased economic activities and appreciation of property values due to their proximity to Putrajaya and its high quality living environment. Thus, it is not unfair to expect the Selangor State Government and the individual stakeholders in the catchment to bear part of the additional costs arising from the implementation of the recommended programs and compliance with the high regulatory requirements set to meet the desired environmental objectives for the Putrajaya Lake and its catchment.

5.3.2.3 An equitable approach has to be found through negotiations between the Federal and State Government of Selangor. As for the individual stakeholders in the catchment the following approach maybe acceptable:

(a) For *existing and committed developments* in the catchment it would be fair to compensate the respective affected stakeholders for the additional costs burden incurred by them as a result of complying with the requirements of the programs in the Lake Catchment Management Plan.

(b) For all uncommitted developments the additional cost associated with complying with the requirements of the programs in the Lake Catchment Management Plan shall be borne by the respective stakeholders, as part of compliance with the regulatory requirements. *The regulatory provisions for the management of the development in the Lake catchment will be further strengthened by the designation of the Putrajaya Lake*

Catchment as a designated sub-catchment under the SWMA Enactment, as recommended by the Consultant.

5.3.3 Funding For The Recommended Programs

5.3.3.1 Based upon the above funding principles the Consultant has identified the possible funding sources for the recommended programs. They are given in Table 5.4 and are discussed below.

5.3.3.2 Water Quality Monitoring Network

The Perbadanan Putrajaya is the primary stakeholder of Putrajaya Lake and is also the body responsible for the monitoring of the water quality in the Lake. Thus, the most likely funding source for this program is the Perbadanan Putrajaya.

5.3.3.3 Development of groundwater well field

The groundwater well field can be developed by the Perbadanan Putrajaya if required to meet the irrigation and other water needs in Putrajaya. Thus, the funding source for this program will be the Perbadanan Putrajaya.

5.3.3.4 Hydrological Monitoring Network

Similar to the water quality monitoring network the hydrological monitoring network is an essential requirement for the management of the Putrajaya Lake. Thus, the most likely funding source for this program is the Perbadanan Putrajaya.

5.3.3.5 Drainage Improvement Program

(1) There is no immediate need for the improvement of the existing drainage systems outside Putrajaya. All of the recommended drainage improvements for the following stakeholders are to be implemented by the respective stakeholders, as part of their normal development cost:

- MARDI
- UPM
- IOI
- West Country
- Cyberjaya

(2) There is a need to ensure that the respective project proponents for the SKVE and ERL implement the recommended vegetated landscape drainage corridor in the MARDI and UPM areas, where the SKVE

TABLE 5.4 POSSIBLE FUNDING SOURCES

FUNDING SOURCE	PROGRAMS	CAPITAL COSTS (RM)	O & M COSTS (RM)	REMARKS
Perbadanan Putrajaya	1. Water Quality Monitoring Network	1,095,000	4,986,400	To be implemented in Year 1 over a 3-year period
	2. Development of groundwater well field	144,000	16,433	To be implemented when needed
	3. Hydrological Monitoring Network	881,000	207,000	To be implemented in Year 1
	4. Sewerage Effluent Monitoring		418,500	To be implemented in Year 1 over a 3-year period
	5. ICMS Installation	20,500		To be implemented in Year 1 for a trial period of 6 months
	6. ICMS Improvement	200,000		To be decided based on 6 months trial
TOTAL COST TO BE BORNED BY PERBADANAN PUTRAJAYA		**2,340,500**	**5,628,333**	
Federal Government	1. Sewerage Improvement Cost	1,094,000		Sewerage Improvement in UPM and MARDI to be implemented in Year 1 (subject to negotiation with UPM and MARDI)
	2. Institutional Strengthening		167,000	1. Annual O & M cost 2. To be implemented in Year 1 3. Subject to negotiation with the Selangor State Government
	3. Drainage Maintenance Cost		152,900	Federal Government to fund maintenance program in areas outside Putrajaya
TOTAL COST TO BE BORNED BY FEDERAL GOVERNMENT		**1,094,000**	**319,900**	
Selangor State Government	Institutional Strengthening		167,000	1. Annual O & M cost 2. To be implemented in Year 1 3. Subject to negotiation with the Federal Government
TOTAL COST TO BE BORNED BY SELANGOR STATE GOVERNMENT			**120,000**	
MARDI	1. Drainage Improvement Cost	8,942,400		To be implemented as part of MARDI's development program
	2. Sewerage Improvement Cost	240,000		Subject to negotiation with Federal Government (to be implemented in Year 1)
TOTAL COST TO BE BORNED BY MARDI		**9,182,400**		
IOI	Drainage Improvement Cost	**72,000**		
TOTAL COST TO BE BORNED BY IOI		**72,000**		
West Country	Drainage Improvement Cost	**31,500**		To be implemented as part of each stakeholder's development program
TOTAL COST TO BE BORNED BY WEST COUNTRY		**31,500**		
Cyberjaya	Drainage Improvement Cost	**81,000**		
TOTAL COST TO BE BORNED BY CYBERJAYA		**81,000**		
SKVE	Drainage Improvement Cost**			
TOTAL COST TO BE BORNED BY SKVE PROJECT		**		To carry out drainage improvement in UPM and MARDI areas which are affected by the respective project ** Costs cannot be ascertained
ERL	Drainage Improvement Cost**			
TOTAL COST TO BE BORNED BY ERL PROJECT		**		
UPM	1. Drainage Improvement Cost	7,776,000		To be implemented as part of UPM's development program
	2. Sewerage Improvement Cost	854,000		Subject to negotiation with Federal Government (to be implemented in Year 1)
TOTAL COST TO BE BORNED BY UPM		**8,630,000**		

and ERL passes through. There is also a need to ensure that the drainage inlets from the SKVE and ERL to the vegetated landscape drainage corridor are provided with GPTs. The costs for complying with the recommended requirements will most probably be the responsibility of the respective project proponents.

(3) The responsibility for the maintenance of the drainage corridors and mini-wetlands in the public areas lies with the pertinent local authorities, whereas those in the individual stakeholder's areas, such as MARDI, UPM and IOI, should be borne by the respective stakeholders. Since the maintenance funds of local authorities are limited the Federal Government may have to develop and fund specific maintenance programs for identified areas outside Putrajaya.

5.3.3.6 Sewerage Improvement/Monitoring Program

(1) There is an immediate need to upgrade the sewage treatment facilities of two student hostels in UPM. IWK has identified the MARDI and UPM areas as part of the sewerage catchment area to be served by its proposed Kota Perdana/Listari central sewerage treament plant. However, the exact date of the implementation of the central sewerage treatment plant is not certain. Thus, in the interim there may be a need to upgrade the sewage treatment facilities of the two student hostels in UPM. The cost for the upgrading will most probably have to be borne by both the Federal Government and UPM.

(2) There is a need to conduct additional monitoring of the quality of the sewage effluent discharge coming from the UPM, MARDI, IOI and Cyberjaya, beyond those required by the DOE. The monitoring can be carried out as an additional part of the water quality monitoring program. The cost for this monitoring program will have to be borne by the Perbadanan Putrajaya.

5.3.3.7 ICMS Installation and Improvement Program

(1) There is an immediate need to purchase the ArcView GIS software and a personal computer for the installation and training in the use of the low-level ICMS, developed as part of this study. The cost for the purchase has to be borne by the Perbadanan Putrajaya. The SWMA may also wish to make the same purchase, and send its staff for the training in the use of the low-level ICMS.

(2) After a recommended trial period of 6 months, the Perbadanan Putrajaya may be able to make a decision on whether to proceed with

further improvement of the ICMS. The next-stage improvement cost for the low-level ICMS will also have to be borne by the Perbadanan Putrajaya.

5.3.3.8 Institutional Strengthening Program (Additional Manpower for MDS)

There is an immediate need to strengthen the existing institutional structure in the Majlis Daerah Sepang to cope with the additional recommended regulatory responsibilities for developments in the areas outside Putrajaya. The costs associated with this program will have to be borne by both the Federal and Selangor State Government.

5.4 COST RECOVERY

5.4.1 The capital expenditure associated with the programs to achieve the environmental objectives and desired living environment for the Lake catchment is not expected to be recovered. However, there is a need for the respective Local, State and Federal authorities to consider the option of implementing a means of cost recovery for the *funding of the maintenance programs* in the Lake catchment area.

5.4.2 A detailed review of the various possible funding options has to be carried out, which is beyond the scope of the current study. The following are two possible equitable policy options for cost recovery:

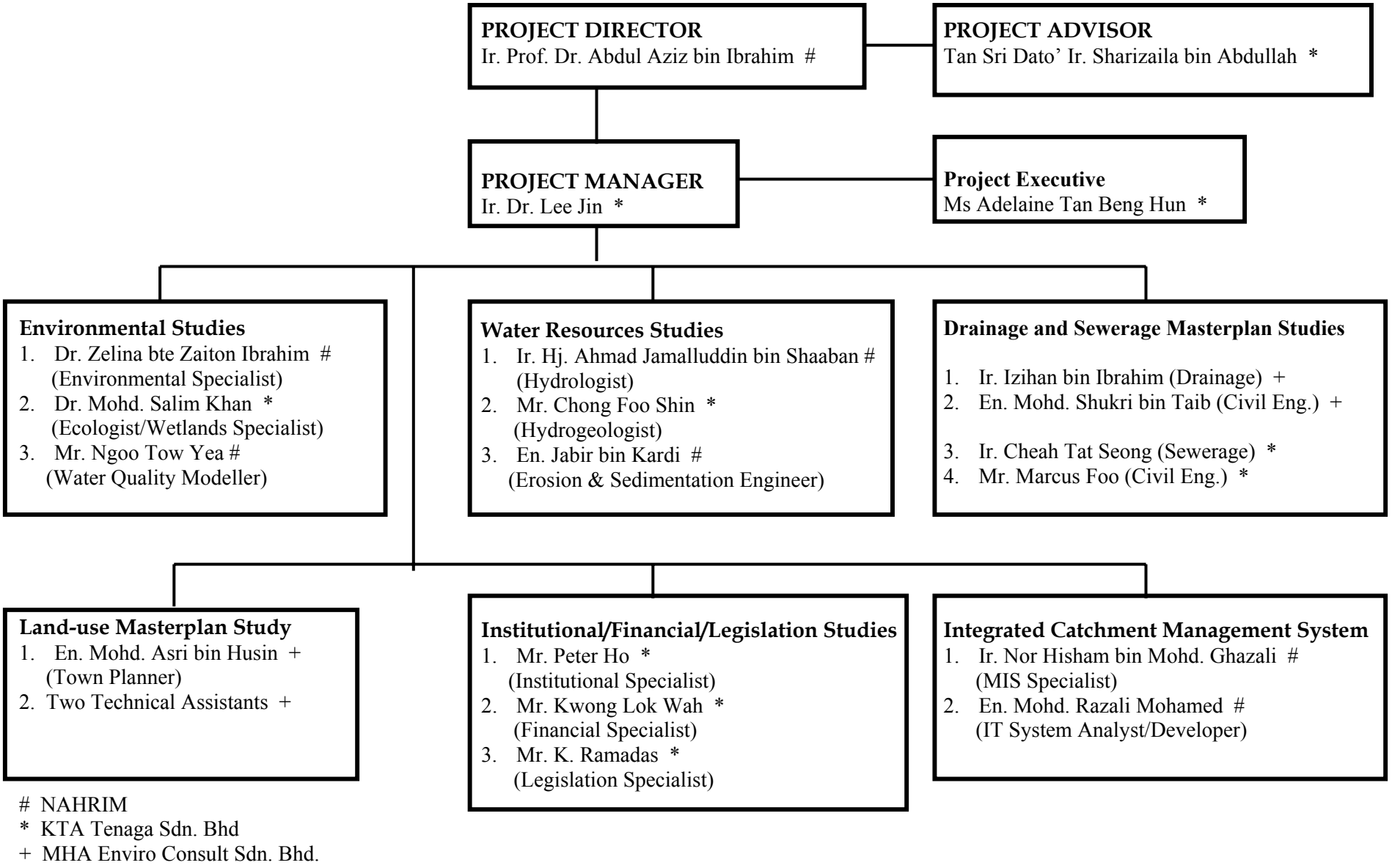
- Adopt and implement the policy of *"the polluter pays"*
- Adopt and implement the policy of "*the direct beneficiaries pays"*

5.4.3 The *"polluter pays"* policy option will require the respective regulatory authorities to diligently enforce all pertinent legislative provisions for the imposition of fines and penalties for causing pollution in the catchment. This would help to encourage regulatory compliance, in addition to being a source of funds for the maintenance programs. The SWMA Enactment provides for quite drastic fines and penalties for causing pollution in a designated catchment.

5.4.4 The *"direct beneficiary pays"* policy option will require the respective regulatory authorities to find ways to collect funds from direct beneficiaries of the enhanced living environment in the Lake catchment. One such way is to put a surcharge on the assessment rates of the property owners in the Lake catchment areas.

APPENDICES

APPENDIX 1 – ORGANISATION OF THE STUDY TEAM



NAHRIM
* KTA Tenaga Sdn. Bhd
\+ MHA Enviro Consult Sdn. Bhd.

APPENDIX 2

PUTRAJAYA LAKE WATER QUALITY STANDARDS

Error! Bookmark not defined. LAKE WATER QUALITY PARAMETER	**UNIT**	**PUTRAJAYA AMBIENT LAKE WATER QUALITY STANDARDS**
Aluminium	mg/l	<0.05 if pH < 6.5 <0.1 if pH > 6.5
Ammmoniacal Nitrogen	mg/l	0.3
Ammonia	mg/l	0.02 - 0.03
Arsenic	mg/l	0.05
Antimony	mg/l	0.03
Barium	mg/l	1
Beryllium	mg/l	0.004
Boron	mg/l	1
Cadmium	mg/l	0.002
Free Chlorine	mg/l	1.5
Chromium, Total	mg/l	0.05
Copper	mg/l	0.02
Cyanide	mg/l	0.02
Flourine	mg/l	1.5
Iron	mg/l	1
Lead	mg/l	0.05
Manganese	mg/l	0.1
Mercury	mg/l	0.0001
Nickel	mg/l	0.02
Nitrate (NO3-N)	mg/l	7
Nitrite (NO2-N)	mg/l	0.04
Total Phosphorus	mg/l	0.05
Silica	mg/l	50
Selenium	mg/l	0.01
Silver	mg/l	0.05
Sulphur	mg/l	0.05
Sulphate	mg/l	250
Zinc	mg/l	5
BOD	mg/l	3
COD	mg/l	25

APPENDIX 2

Error! Bookmark not defined. LAKE WATER QUALITY PARAMETER	**UNIT**	**PUTRAJAYA AMBIENT LAKE WATER QUALITY STANDARDS**
Colour	TUC	150
Conductivity	uS/cm	1000
Salinity	ppt	1
Total suspended solids	mg/l	50
Turbidity	NTU	50
Transparency (Secchi)	m	0.6
Hardness	mg/l	250
Taste		No Objectionable Taste
Dissolved Oxygen	mg/1	5 - 7
Odour		No Objectionable Odour
pH		6.5 - 9.0
Temperature	°C	Normal±2
Oil & Grease	mg/l	1.5
Chlorophyll a	ug/l	0.7
Floatables		No Visible Floatables
Microbiological Constituents		
Feacal coliform	counts/100ml	100
Total coliform	counts/100ml	5000
Salmonella	counts/l	0
Enteroviruses	PFU/l	0
Radioactivity		
Gross-alpha	Bq/l	0.1
Gross-Beta	Bq/l	1
Radium-226	Bq/l	<0.1
Strontium-90	Bq/l	<1
Organics		
Carbon Chloroform Extract	ug/l	500
MBAS/BAS	ug/l	500
Oil & Grease (mineral)	ug/l	40;NF
Oil & Grease (emulsified edible)	ug/l	7000;NF
PCB	ug/l	0.1
Phenol	ug/l	10
Aldrin/Dieldrin	ug/l	0.02

APPENDIX 2

Error! Bookmark not defined. LAKE WATER QUALITY PARAMETER	**UNIT**	**PUTRAJAYA AMBIENT LAKE WATER QUALITY STANDARDS**
BHC	ug/l	2
Chlordane	ug/l	0.08
t-DDT	ug/l	0.1
Endosulfan	ug/l	10
Heptachlor/Epoxide	ug/l	0.05
Lindane	ug/l	2
2,4-D	ug/l	70
2,4,5-T	ug/l	10
2,4,5-TP	ug/l	4
Paraquat	ug/l	10

APPENDIX 3

TERMS OF REFERENCE FOR IRRIGATION MASTER PLAN STUDY FOR PUTRAJAYA

1.0 INTRODUCTION

Putrajaya is being developed as the new Federal Government Administrative Centre. Its development master plan emphasises a "City in a Garden" concept with generous open spaces and parks, and a 552-hectare man-made lake, the Putrajaya Lake, as its principal landscape feature and focal point. In order to ensure that the extensive vegetated landscape in the open areas and 13 parks within Putrajaya are well maintained there is a need to develop irrigation systems to meet the optimum water demand of the vegetated landscape planned for the parks and open areas. Currently, the irrigation water demand and internal irrigation systems for four of the 13 parks are being assessed and developed, respectively, by the irrigation consultants of the developers for the four parks.

The Putrajaya Lake has been identified as one of the primary sources to meet the irrigation water demand in Putrajaya. However, there is a concern that the water quality in the Lake may deteriorate if excessive quantities of water are drawn from the Lake to meet the irrigation demand, especially during drought periods.

There is thus a need for a detail study to assess the total irrigation demand and develop an integrated irrigation master plan for Putrajaya. There is also a need to identify and quantify alternative sources of irrigation water, and develop the irrigation strategies for various operational and irrigation demand scenarios.

2.0 OBJECTIVES OF STUDY

The objectives of this study are as follows:

(a) To conduct a detail assessment of the total irrigation water demand in Putrajaya,
(b) To identify the possible irrigation water sources and quantities available from them to meet irrigation demand,

(c) To develop the irrigation strategies to meet irrigation demand, for various operational and irrigation demand scenarios, including consideration of recycling and re-use of effluent water,

(d) To prepare a comprehensive integrated irrigation master plan for the whole of Putrajaya development, which shall include the design of the hardware and software of the interlinked abstraction/ diversion systems and all trunk and secondary distribution mains.

3.0 SCOPE OF WORK

The scope of work shall include the following:

(a) Assessment of total irrigation demand

1. To collect, compile and review all pertinent information and data required for the assessment of the total irrigation demand.
2. To review the irrigation demand prepared by the irrigation consultants for the four parks and use them as the basis for extrapolation of the irrigation demands for planned vegetated landscape in the other parks and open areas in Putrajaya.

(b) Identification of possible irrigation water sources and amounts

1. To identify all possible sources of irrigation water, such as from the Putrajaya Lake, rainwater storage, groundwater and reuse/ recycle of effluent discharge.
2. To assess the optimum amount of irrigation water available from the Putrajaya Lake, for the wet, normal and dry hydrological years. The assessment shall take into account the water quality requirements in Putrajaya Lake and shall involve water quality modeling. For the water quality modeling work the Consultant is required to work with the National Hydraulic Research Institute of Malaysia (NAHRIM), which has calibrated a water quality model for the Lake.
3. To assess the amount of rainwater that can be collected in rainwater storage ponds in Putrajaya for the wet, normal and dry hydrological years.
4. To assess the amount of groundwater and effluent discharge available for irrigation purposes.

(c) Development of irrigation strategies

1. To match the irrigation water demand to the available irrigation water supply and develop the irrigation strategies for the wet, normal and dry hydrological years, including consideration of recycling and re-use of effluent water.

2. To recommend the optimum combination of vegetation types for the parks, as one of the strategies to manage the irrigation water demand.
3. To recommend structural and non-structural measures to increase on-site infiltration and retention of rainwater, as part of the irrigation strategies.

(d) Preparation of a comprehensive integrated irrigation master plan

1. Based on the results from (a), (b) and (c) to prepare a comprehensive integrated irrigation master plan for the whole of Putrajaya development. The work shall include the following:

   - Design of the interlinked abstraction/ diversion systems which shall include the land requirements, intake points, pumping systems, transfer stations together with the necessary operational software system.
   - Design of the trunk and secondary distribution mains to parcel boundary, which shall include the pumping system, transfer stations, intake and tapped-off points, land requirements, etc.
   - An irrigation operation manual.
   - Proposed operational facilities, both hardware and software, for the implementation of the Plan.
   - An Integrated Irrigation Management System to support decision making and management of the irrigation in Putrajaya. The System shall contain information related to policy, legislation, strategies and programs, organisational set-up and operational requirements, associated with all irrigation management issues in Putrajaya.
   - An implementation schedule and implementation budget for the Plan.

APPENDIX 4

Development Control Requirements and Guidelines for Inclusion in the Local Plans for the Areas within the Putrajaya Lake Catchment, Outside Putrajaya

BACKGROUND

Putrajaya is envisaged to be developed into a "City in a Garden" with the 552 hectares Putrajaya Lake as its focal point. The Lake is required to cater for multi-functional uses and thus has to be always in pristine condition, with a high water quality.

To achieve and maintain the high water quality objective set for Putrajaya Lake a comprehensive Catchment Development and Management Plan for the Putrajaya Lake Catchment Study Report has been prepared. The Plan comprises of a:

- Land-use Masterplan
- Drainage Masterplan
- Sewerage Masterplan

The development in Putrajaya is controlled by the Putrajaya Masterplan. For the areas outside Putrajaya there is a need to ensure that the land-use, drainage and sewerage development are governed by similar master plans. The mechanism for this is through the Local Plan that is currently being prepared by the Jabatan Perancang Bandar dan Desa (JPBD) for the Multi-Media Super-Corridor area, excluding Cyberjaya and Putrajaya.

To facilitate the JPBD in the preparation of the Local Plan for the areas outside Putrajaya the following pertinent recommendations on land-use, drainage and sewerage development in the areas outside Putrajaya have been compiled from the Study Report.

Note: Please see Figure 3.6 in Volume 1 of the Study Report for a copy of the proposed Land-use masterplan for the areas outside Putrajaya. Table 1.0 shows the proposed land-use masterplan and Table 2.0 shows the Use-Class Order Tables, describing the proposed allowable land-use activities in each of the land parcels.

TABLE 1 : 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	59.48	-	-	-	-	-	-	66.45	27.40	-	-	-	-	217.83	11.90
Hostels/College	213.68	29.52	-	-	-	-	-	-	-	-	-	-	-	-	-	-	213.68	11.67
Housing/Quarters	-	-	19.30	7.58	132.20	82.14	-	-	236.26	100.00	121.45	50.00	89.60	100.00	-	-	598.81	32.71
Commercial	-	-	-	-	17.46	10.86	-	-	-	-	12.15	5.01	-	-	-	-	29.61	1.62
Academic/R&D	312.89	43.23	-	-	-	-	-	-	-	-	-	-	-	-	93.80	100.00	406.69	22.22
Power Station	-	-	-	-	-	-	28.95	100.00	-	-	-	-	-	-	-	-	28.95	1.58
Facilities	197.25	27.25	83.82	32.94	11.27	7.00	-	-	-	-	42.48	15.02	-	-	-	-	334.82	18.29
TOTAL	723.82	50.94	254.50	22.16	160.93	30.77	28.95	12.98	236.26	61.96	242.53	39.96	89.60	100.00	93.80	100.00	1,830.39	41.77
B. GREEN AREAS																		
Open Space/Field Recreation	189.66	49.28	155.02	23.59	5.82	2.61	-	-	17.66	-	110.06	100.00	-	-	-	-	478.22	29.91
Golf Course	186.51	48.46	-	-	216.90	97.39	-	-	-	-	-	-	-	-	-	-	403.41	25.23
Farms	-	-	141.21	21.49	-	-	-	-	-	-	-	-	-	-	-	-	141.21	8.83
Orchards	-	-	354.96	54.01	-	-	-	-	-	-	-	-	-	-	-	-	354.96	22.20
Buffer Zone	8.67	2.25	6.01	0.91	-	-	194.03	100.00	5.34	23.22	7.23	-	-	-	-	-	221.28	13.84
TOTAL	384.84	27.09	657.20	57.22	222.72	42.59	194.03	87.02	23.00	6.03	117.29	19.32	-	-	-	-	1,599.08	36.49
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	31.68	24.47	89.63	-	-	55.27	53.26	48.22	24.58	-	-	-	-	242.85	32.42
Express Rail Link	73.86	29.13	48.32	28.71	-	-	-	-	-	-	35.77	18.23	-	-	-	-	157.95	21.09
Highway	118.08	46.58	66.68	39.62	-	-	-	-	47.20	45.49	81.85	41.72	-	-	-	-	313.81	41.89
Others	-	-	-	-	2.83	10.37	-	-	1.30	1.25	30.35	15.47	-	-	-	-	34.48	4.60
TOTAL	253.51	17.84	168.32	14.66	27.30	5.23	-	-	103.77	27.21	196.19	32.32	-	-	-	-	749.09	17.09
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

TABLE 2: LAKE CATCHMENT LANDUSE MASTERPLAN – USE CLASS ORDER

LAKE CATCHMENT AREA (PLOT)	PERMITTED USE	PERMITTED WITH CONDITION		NON PERMITTED USE
UPM	**INSTITUTIONAL**	**Activities**	**Conditions**	
Institutional Centre Total Area: 1,420.86 acre	• Hostels/College • Faculty • Administration Centre • R&D Centre • Farms & Orchards • Open Space/Feild • Library • Laboratory	• Hospital • Staff Quarters • Supporting Commercial - Bank, Shop, Food court, clinic etc. • Mosque • Pedestrian walk • Buffer Zone • Sewage Treatment Plant • Road/Drainage • Highway/ERL	• 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 • Fetilizer & 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	• 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
MARDI	**REASEARCH CENTRE**	**Activities**	**Conditions**	
Research Centre Total Area: 1,148.52 acre	• Administration Office • R&D Centre • Laboratory • Store • Farms & Orchards • Nursery	• Staff Quarters • Hostels • Supporting Commercial - Canteen, Food court, etc. • Buffer zone • Recreation/Open Space • Lake/pond • Road/Drainage • Highway/ERL	• 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	• 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	• Low Density Housing - Bungalow lots • Sports and recreations • Open Space/Feild	• Neighbourhood Commercial - Club House - Nursery Centre - Health Club - Shops - Clinic • Golf Course • Road/Drainage	• 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 • Fetilizer & 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	• 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	• Power Plant • Green Network - Reserve for electric line - Buffer Zone	• Recreation • TNB Facilities • Open Space/Feild	• 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	• Any development accept TNB use
WEST COUNTRY BHD.	**HOUSING**	**Activities**	**Conditions**	
Housing Total Area: 381.33 acre	• Low Density Housing - Bungalow lots • Sports and recreations •	• Neighbourhood Commercial - Shops, Clinic etc. • Institutional • Lake/pond • Sewage Treatment Plant • Road/Drainage • Highway	• 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 • Fetilizer & 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	• 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	• Low & Medium Density Housing • Commercial - shops, clinic, bank, food court etc. • Offices • Open Space/Feild •	• Institutional • Commercial • Public facilities • Recreation • Lake/pond • Sewage Treatment Plant • Road/Drainage • Highway/ERL	• 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 • Fetilizer & 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	• 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	• Hostels/College • Faculty • Administration Centre • R&D Centre • Farms & Orchards • Open Space/Feild • Library • Laboratory	• Staff Quarters • Supporting Commercial - Bank, Shop, Food court, clinic etc. • Mosque • Pedestrian walk • Buffer Zone • Sewage Treatment Plant • Road/Drainage • Highway/ERL	• 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 • Fetilizer & 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	• 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	• Low Density Housing - Bungalow lots - Cluster - Semi Detached	• 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	• To comply with Guidelines - Planning Standard, Lake Catctment, 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 • Fetilizer & 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	• 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)

I. LAND-USE PLAN

(a) Generic Requirements

The design concept of all proposed development in the Putrajaya Lake catchment shall 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.
- 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

- All project proponent are required to prepare and submit an Environmental Management Plan (EMP) following the format and requirements of the Putrajaya Environmental Management Guide.
- All project proponent are required to ensure that their contractors prepared an EMP for their approval before commencement of construction work. They are required to ensure that the contractor implements the EMP.
- 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.
- 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 continuos 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

(a) Roads

Throughout the development region, the road networks should consist of the following hierarchy:

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.

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.
- 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.
- lane single-carriageways with no access control.

vi. Walkways and Road Reserves

- 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.

(b) Drainage (Please see Section III. Below)

(c) Sewerage (Please see Section II. Below)

7. Construction

- Before the commencement of any construction work an Environmental Management Plan (EMP) has to be developed and approved by the project proponent.
- All 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.

(b) Specific Guidelines

1. Universiti Putra Malaysia (UPM)

- All development must follow the 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 element e.g laboratories, sports complex, shops, mosque etc.
- Medical/laboratory development should discharged 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 are 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 continuos network of green belt and buffer that runs throughout the whole development.
- Functional open spaces should be provided to be utilised 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 follows 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 for all side set-back.
- 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 well balanced 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 which can generate economic gains such as Theme Parks, Botanical Garden and Herbal Garden 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 continuos network of green belt and buffer that runs throughout the whole development.
- Functional open spaces should be provided to be utilised 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 balanced and attractive building skylines which are 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 follows 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.
- 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 skylines which are 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 follows Planning Standard, Lake Catchment Guidelines, Putrajaya Guidelines and MSC Guidelines.
- Faculty, Hostels, Administration and other supporting institutional 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 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 are 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.

- 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 continuos network of green belt and buffer that runs throughout the whole development.
- Functional open spaces should be provided to be utilised 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 follows 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 skylines which are 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 existing water bodies such as ex-mining pools for flood prevention purposes.

II. SEWERAGE PLAN

(a) Generic Requirements

1. Wherever possible and applicable, all treated sewage effluents from the developments in the Putrajaya Lake catchment shall be channelled outside the catchment.

2. The sewage flows shall be conveyed by sewer networks, including pumping station(s), to a sewage treatment plant.

3. All treated sewage effluent discharge within the Putrajaya Lake catchment are to meet the Recommended Effluent Standard for the Putrajaya Lake Catchment.

4. All treated effluents, where possible, are to be directed into drainage detention ponds/mini wetlands, before flowing into the Putrajaya Lake system.

(b) Specific Requirements

1. UPM and MARDI

- The UPM and MARDI shall be served by an integrated sewerage system, which is to be connected to a central sewage treatment plant, located to the north of the Upper North Wetlands.
- The central sewage treatment plant is to be located outside the Putrajaya Lake catchment and all treated sewage effluent discharge are to be discharged outside the catchment.
- The system shall replace the existing individual sewage treatment system serving individual buildings in UPM and MARDI.

- The proposed central sewerage works can be integrated with the IWK sewerage development plan for the sewerage sub-catchment of Kota Perdana/Lestari in the region.

2. IOI Palm Garden Resort Development

- The proposed sewerage plan for the whole IOI Palm Garden Resort development should be implemented.
- Monitoring of the water quality for the combined flows at the outfall shall be carried out.

3. West Country Development

- The treated sewage effluent discharge from the West Country Development shall be discharge outside the Putrajaya Lake catchment.

4. Cyberjaya Flagship Zone

- The proposed Cyberjaya Flagship Zone Sewerage Plan shall be implemented to ensure that no treated sewage effluent discharge will discharge into the Phase 2 Putrajaya Lake when it is impounded.

5. Sg. Merab Malay Reserve

- The treated effluent from the future mixed development of Kg. Sg. Merab area shall be diverted outside the Putrajaya Lake catchment, i.e.into Sg. Merab.

III. DRAINAGE PLAN

(a) Generic Requirements

- All drainage design shall comply with the requirements of the Putrajaya Stormwater Management Design Guidelines.
- 5% of any proposed development shall be reserved for flood detention ponds, in accordance with DID guidelines.
- Wherever possible, all drainage system should be based on vegetated landscape drainage corridors and conversion of flood detention ponds into mini-wetlands, as illustrated schematically in Figures 1 and 2.
- Where possible, all drainage lines should terminate at detention ponds converted into mini-wetlands. The detention ponds shall be connected to the Putrajaya Lake through a vegetated landscape drainage corridor.
- Gross Pollutant Traps (GPTs) are to be provided at all inlets into the detention ponds and to the main trunk drainage systems.
- All storm drains should be connected to a system of trunk and secondary drains which ends at an existing river/waterbody.
- 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.

(b) Specific Requirements

1. MARDI

(a) This area will be conserved as a green-lung area and will be developed as a natural and green theme park. Thus, the development of its drainage system shall emphasise the preservation and enhancement of the existing streams and water bodies in the area.

(b) The existing stream network shall be improved with the provision of a vegetated landscape river corridor.

(c) The design for the river corridor shall be based on the following principles.

- Water shall flow slowly in the channel and should not cause scouring of the drainage channel.
- Grass and reeds shall be allowed to grow in the channel to retard the flow. They will also reduce the pollutants and sediments carried by the runoff into the channel.

(d) The proposed South-Klang Valley Expressway (SKVE) and Express Rail Link (ERL) passes through the South of MARDI. There will be some diversions and realignment of the existing drainage lines in the area. However, it is recommended that the existing riparian buffer and natural vegetated river corridor concept be preserved for the revised drainage lines. They should not be replaced with concrete channels.

(e) Also, the drainage outlets from the SKVE and ERL drainage systems should be provided with GPTs before they drain into the existing natural vegetated landscape drainage system connecting to the Upper West Wetland.

2. UPM

(a) It is recommended that the similar concept to drainage design be implemented in the UPM as in MARDI. This is because the area is large and there is enough natural green area, with existing ponds, for the drainage engineer to be creative in the design of the drainage system.

(b) The concept is to retard the flow of water into the Putrajaya wetlands, from the UPM area, through a series of detention ponds. Also, to improve the quality of the runoff before it flows into the wetlands it is recommended that natural vegetated landscape riparian buffers and river corridors be provided.

3. IOI

(a) A series of existing and proposed detention ponds are located in this area.

(b) To improve the water quality of the runoff from the area it is recommended that the last pond in the series of proposed ponds draining into the Upper

North and Upper East Wetlands be converted into mini-wetlands and designed as wet-detention ponds. Also, it is recommended that the drain leading from the last pond into the wetlands be designed as earth-drains, vegetated and landscaped to blend into the surroundings.

(c) The detention ponds in the proposed development must be properly designed. It must follow the DID guideline of 5% of the catchment area being reserved for detention ponds. .

4. **West Country Bhd.**

(a) West Country Bhd. has proposed a drainage system for this area that comprises of an 11.0 acres (4.4 ha) flood detention and recreational lake, which is cut into two by the proposed Putrajaya-SKVE access road.

(b) To ensure "minimum disruption to the existing drainage system" the lake should be created with minimum earthworks and the existing streams are to be upgraded through the provisions of vegetated landscape drainage corridors and mini wetlands cum detention ponds.

(c) It is recommended that the drainage consultant for West Country adopts the above concept and revised its proposed drainage layout to incorporate the vegetated landscape drainage corridors in its development. The last pond in the proposed drainage system, which connects to the Upper East wetlands, should be a mini wetland type pond. Also, the existing stream should be preserve and upgraded as the connecting drain between the last pond and the Upper East wetlands.

(d) All the concrete drains in the proposed revised drainage system leading into the upgraded existing streams should be provided with GPTs.

APPENDIX 5
COMPARISON OF VARIOUS STANDARDS

ITEM	PARAMETER (mg/l Unless Otherwise Stated)	LIMITING VALUE			
		RECOMMENDED EFFLUENT STANDARD FOR PUTRAJAYA LAKE CATCHMENT	DOE'S STANDARD A	PUTRAJAYA LAKE AMBIENT WATER QUALITY STANDARD	INTERIM NATIONAL RIVER WATER QUALITY STANDARD MALAYSIA - CLASS IIB
1.	Temperature (°C)	40	40	Normal ± 2	
2.	pH (units)	6.0 - 9.0	6.0 - 9.0	6.5 - 9.0	6.0 - 9.0
3.	BOD_5 at 20°C	20	20	3	3
4.	COD	50	50	25	25
5.	Suspended Solids	50	50	50	50
6.	Mercury	0.005	0.05	0.0001	0.001
7.	Cadmium	0.01	0.01	0.002	0.01
8.	Chromium, hexavalent	0.05	0.05	0.005	0.05
9.	Arsenic	0.05	0.05	0.05	0.05
10.	Cyanide	0.05	0,.05	0.02	0.02
11.	Lead	0.10	0.10	0.05	0.05
12.	Chromium, trivalent	0.20	0.20	-	-
13.	Copper	0.20	0.20	0.02	0.02
14.	Manganese	0.20	0.20	0.10	0.1
15.	Nickel	0.20	0.20	0.02	0.05
16.	Tin	0.20	0.20		-
17.	Zinc	1.0	1.0		5.0

ITEM	PARAMETER (mg/l Unless Otherwise Stated)	LIMITING VALUE			
		RECOMMENDED EFFLUENT STANDARD FOR PUTRAJAYA LAKE CATCHMENT	DOE'S STANDARD A	PUTRAJAYA LAKE AMBIENT WATER QUALITY STANDARD	INTERIM NATIONAL RIVER WATER QUALITY STANDARD MALAYSIA - CLASS IIB
18.	Boron	1.0	1.0	1.0	1.0
19.	Iron	1.0	1.0	1.0	1.0
20.	Phenol	0.001	0.001		10
21.	Free Chlorine	0.5	1.0	1.5	-
22.	Sulphide	0.5	0.5		
23.	Oil and Grease	Not Detectable	Not Detectable	1.5	
24.	Dissolved Oxygen	5.0		5.0 - 7.0	5.0 - 7.0
25.	Total Phosphorous	2.0		0.05	0.2
26.	Total Nitrogen	10.0			
27.	Nitrate (NO_3 - N)	-		7.0	7.0
28.	Nitrite (NO_2 - N)	-		0.04	0.4
29.	E-Coli (Counts/100 ml)	400		100	400
30.	Total Coliform (Counts/100 ml)	5,000		5,000	5,000
31.	Salmonella (Counts/l)			0	
32.	Enteroviruses (PFU/l)			0	
33.	Chlorophyll a (ug/l)			0.7	
34.	Floatables			Not Visible	Not Visible
35.	Colour (TUC)			150	150
36.	Conductivity (ms/cm)			1,000	1000

ITEM	PARAMETER (mg/l Unless Otherwise Stated)	LIMITING VALUE			
		RECOMMENDED EFFLUENT STANDARD FOR PUTRAJAYA LAKE CATCHMENT	DOE'S STANDARD A	PUTRAJAYA LAKE AMBIENT WATER QUALITY STANDARD	INTERIM NATIONAL RIVER WATER QUALITY STANDARD MALAYSIA - CLASS IIB
37.	Salinity (ppt)			1.0	1.0
38.	Turbidity (NTU)			50	50
39.	Transparency (Secchi)			0.6	
40.	Hardness			250	250
41.	Taste			No Objectional	No Objectional
42.	Odour			No Objectional	No Objectional
43.	Aluminium			<0.05 if pH < 6.5 <0.01 if pH > 6.5	-
44.	Ammoniacal Nitrogen			0.3	0.3
45.	Ammonia			0.02 - 0.03	
46.	Antimony			0.03	
47.	Barium			1.0	1.0
48.	Beryllium			0.004	
49.	Flourine			1.5	1.5
50.	Silica			50	50
51.	Selenium			0.01	0.01
52.	Silver			0.05	0.05
53.	Sulphur			0.05	0.05
54.	Sulphate			250	250
55	Gross-alpha (Bq/l)			0.1	0.1

ITEM	PARAMETER (mg/l Unless Otherwise Stated)	LIMITING VALUE			
		RECOMMENDED EFFLUENT STANDARD FOR PUTRAJAYA LAKE CATCHMENT	DOE'S STANDARD A	PUTRAJAYA LAKE AMBIENT WATER QUALITY STANDARD	INTERIM NATIONAL RIVER WATER QUALITY STANDARD MALAYSIA - CLASS IIB
56.	Gross-Beta (Bq/l)			1.0	1.0
57.	Radium-226 (Bq/l)			<0.1	<0.1
58.	Strontium-90 (Bq/l)			<1.0	<1
59.	Carbon Chloroform Extract (ug/l)			500	500
60.	MBAS/BAS (ug/l)			500	500
61.	Oil & Grease (mineral) (ug/l)			40, NF	40 ; NF
62.	Oil & Grease (emulsified edible) (ug/l)			700, NF	7,000 ; NF
63.	PCB (ug/l)			0.1	0.1
64.	Aldrin/Dieldrin (ug/l)			0.02	0.02
65.	BHC (ug/l)			2.0	2.0
66.	Chlordane (ug/l)			0.08	0.08
67.	t-DDT (ug/l)			0.1	0.1
68.	Endosulfan (ug/l)			10	10
69.	Heptachlor/Epoxide (ug/l)			0.05	0.05
70.	Lindane (ug/l)			2.0	2.0
71.	2,4-D (ug/l)			70	70
72.	2,4,5-T (ug/l)			10	10
73.	2,4,5-TP (ug/l)			4.0	4.0
74.	Paraquat (ug/l)			10	10

APPENDIX 6

TERMS OF REFERENCE FOR SUB-CATCHMENT MANAGEMENT COMMITTEE

The following is the suggested Terms of Reference for the Sub-Catchment Management Committee:

1. To review land use and development plans in the catchment areas outside Putrajaya and to advise the Selangor Waters Management Authority (SWMA), and such other local and state authorities or agencies, on acceptable land use or development for the areas, so as to support the integrated management of the Lake catchment.

2. To advise the SWMA and such other local and state authorities on acceptable land use for the structure and local plans that are to be prepared for the areas;

3. To review and assess water quality trends in the streams, wetlands and the Lake and to make recommendations for pollution control and enforcement action in the areas, where this is necessary to protect the water quality;

4. To review the monitoring programme and make recommendations for changes in the areas, where they are required to enhance catchment management;

5. To review and advise on acceptable physical and engineering works in the areas, which are necessary for water quality management and catchment protection; and

6. To advise on stakeholders' participation in catchment management and to refer matters that affect stakeholders to the Stakeholders' Group for review and feedback.

APPENDIX 7

TERMS OF REFERENCE FOR STAKEHOLDERS' GROUP

The following are the suggested Terms of Reference for the Stakeholders' Group (SG):

1. To review matters related to management of the Putrajaya Lake Catchment that is referred to the SG by the Sub-Catchment Management Committee (SCMC);

2. To provide feedback or decisions to the SCMC on matters referred to it where this requires a decision of members of the SG; and

3. To consult, where necessary, with members of the public, land owners or residents' association and such other individuals or groups on matters (referred by the SCMC) related to management of the Putrajaya Lake Catchment that are likely to affect them.