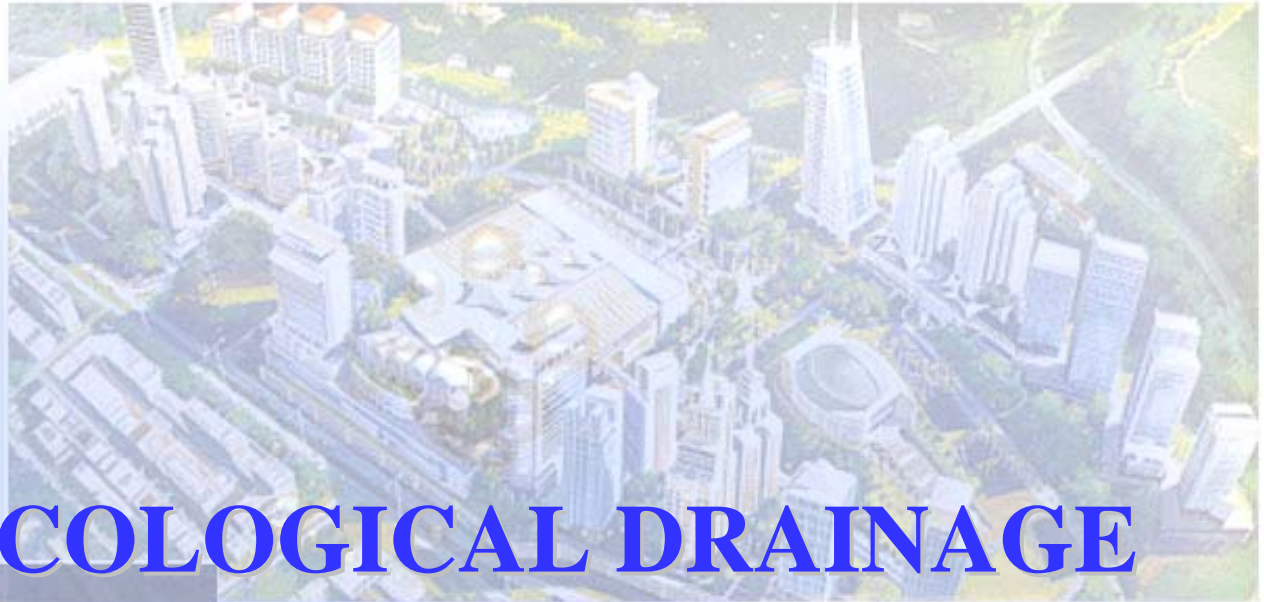




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BIO-ECOLOGICAL DRAINAGE SYSTEM(BIOECODS):CONCEPTS, DESIGN AND CONSTRUCTION



BIOECODS

Bio-Ecological Drainage System, Malaysia





CONTENTS

- INTRODUCTION
- CONSTRUCTED COMPONENTS
- DESIGN CONCEPTS
- DESIGN CRITERIA
- ECOLOGICAL SWALE MATERIALS
- CONSTRUCTION EXPERIENCE
- CONCLUSION





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INTRODUCTION



INTRODUCTION



□ This project has taken various measures to reduce stormwater runoff rates and volumes, and stormwater pollutant load by implementing control at source method.

□ BIOECODS is the first project that uses control at source method in Malaysia and attempts to solve three major problems in Malaysia:

Flash Flood

River Pollution

Water Scarcity



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RESEARCH DEVELOPMENT

□ Design - 1999

□ Construction- Starts: 2000

Completed: 2002

□ Data Collection – Starts: June 2003



PROJECT LOCATION



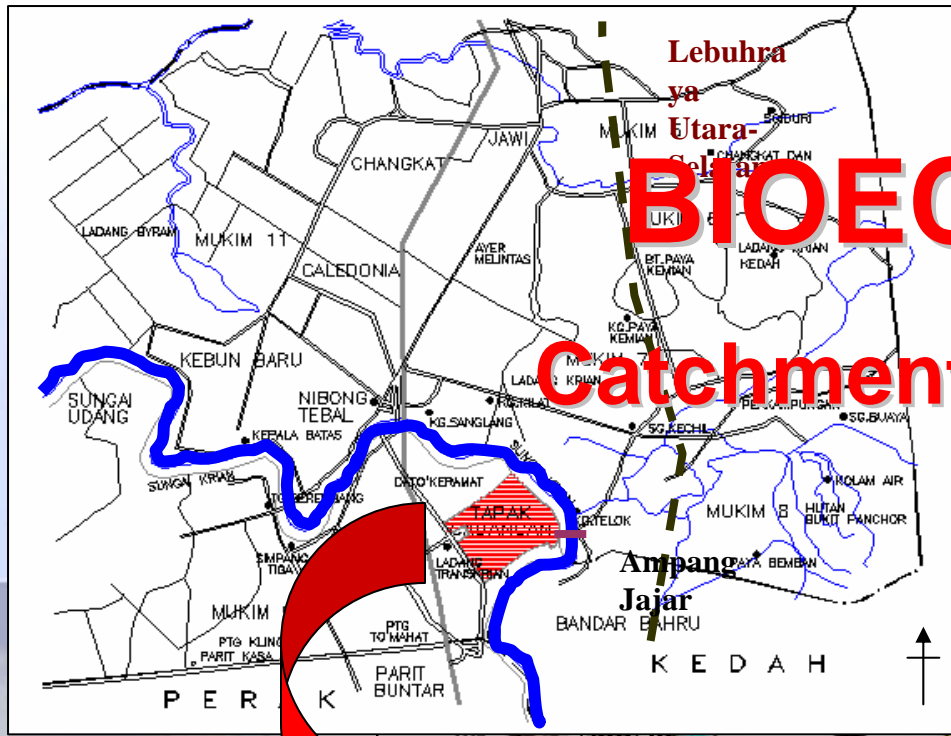
□ USM Engineering Campus is located in District 9 of the Southern Part of Penang .





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BIOECODS SITE

Catchment Area: 320 acres



SITE ORIGINAL CONDITIONS



- Flat, Low-lying area subject to tidal influence
- Palm Oil Plantation Estate
- Peaty and clayey type of soil (min 25 m depth)
– not an engineered soil
- Permeability is negligible
- For construction, average filling of 2 to 3 m of laterite (red clay)



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DESIGN CONCEPTS



SCHEMATIC LAYOUT OF BIOECODS



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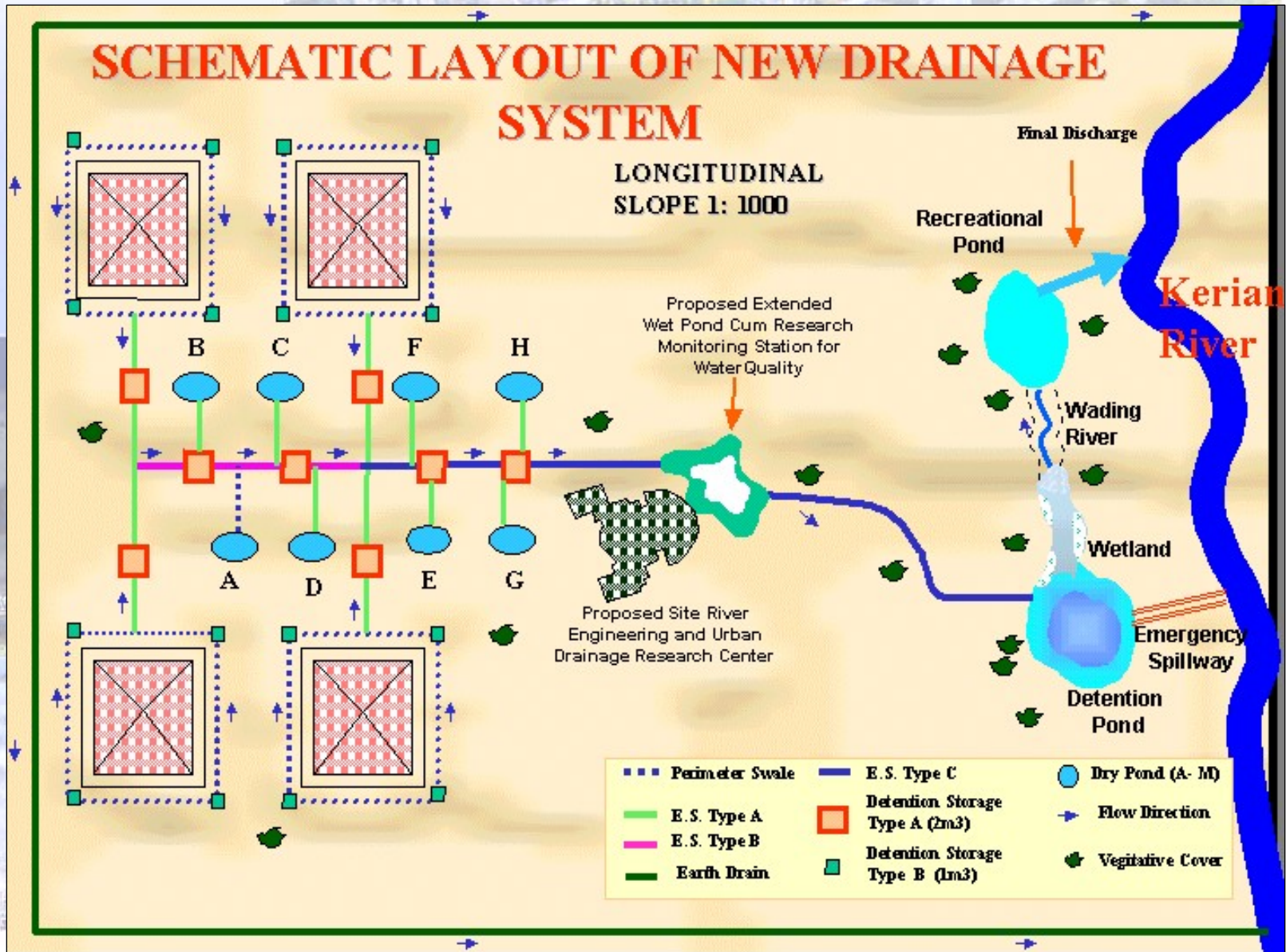
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SCHEMATIC LAYOUT OF NEW DRAINAGE SYSTEM



DESIGN CONCEPTS



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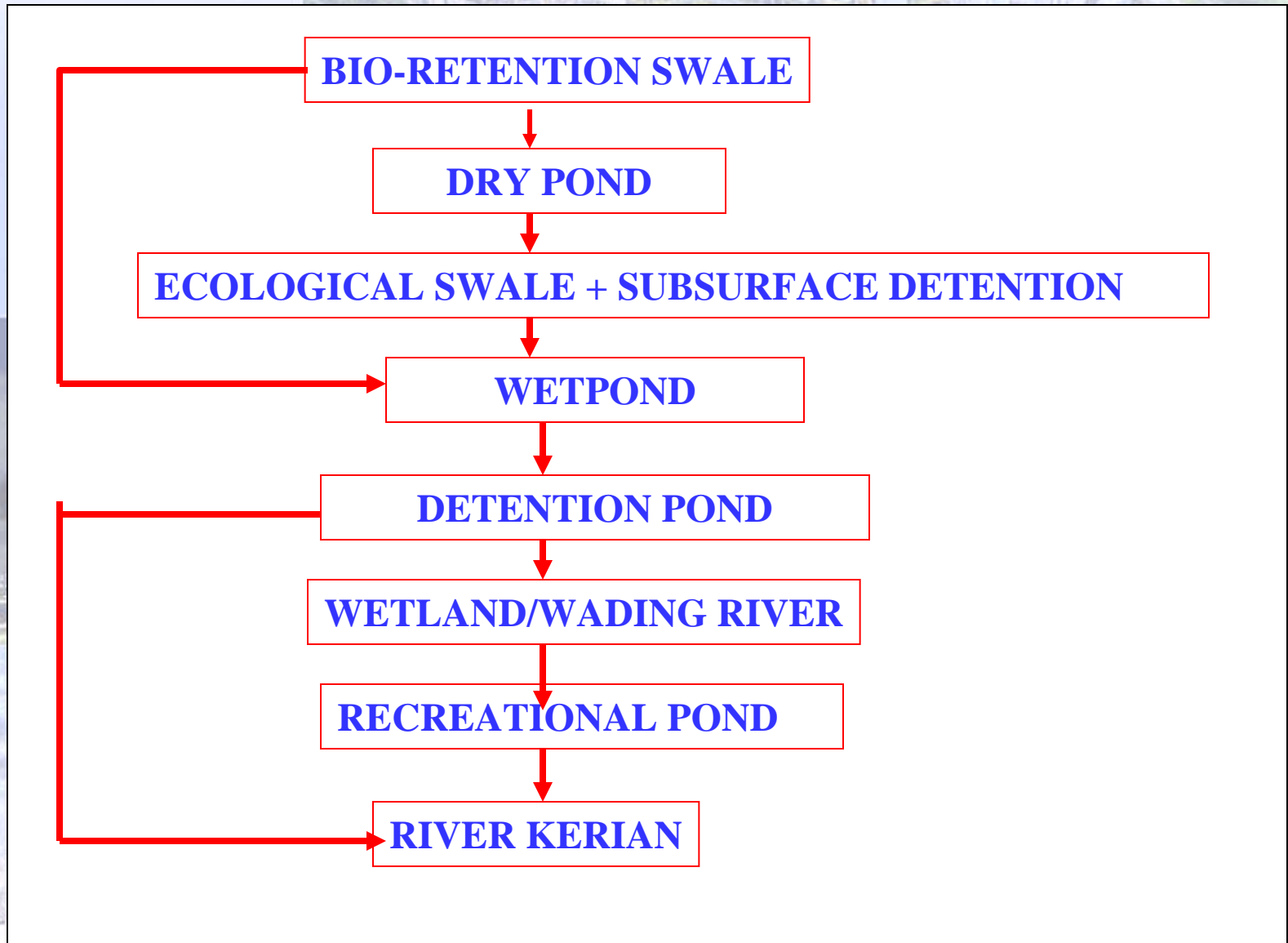
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DESIGN CRITERIA



DESIGN CRITERIA

Ecological Swale



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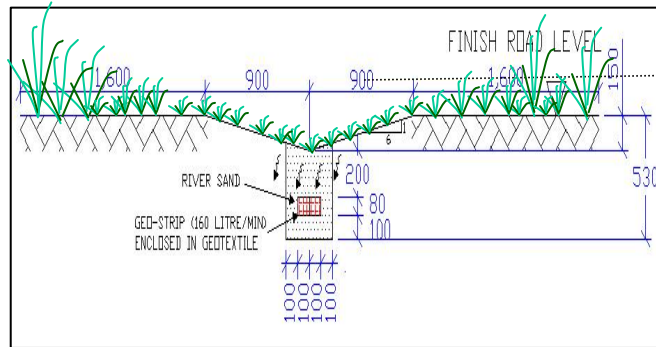
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Design Parameter	Criteria
Longitudinal Slope	1:1000
Manning Roughness Coefficients	Surface Swale=0.035 Sub-Surface Drainage Module=0.1
Design Rainfall	10-year ARI and Check For 100-Year ARI
Maximum Period of Surface Water Inundation at Surface Swale	24 hours

ECOLOGICAL SWALE

i) Perimeter Swale



a) Cross Section

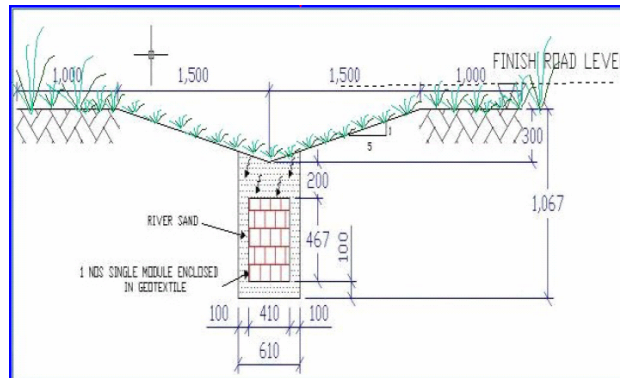


b) Typical View



ECOLOGICAL SWALE

ii) Type A



a) Cross Section

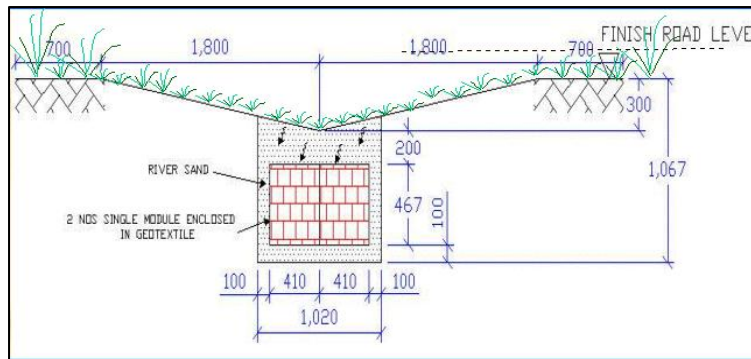


b) Typical View



ECOLOGICAL SWALE

iii) Type B



a) Cross Section

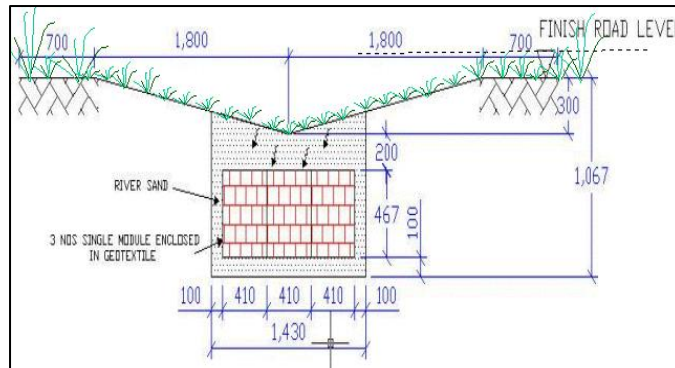


b) Typical View



ECOLOGICAL SWALE

iv) Type C



a) Cross Section



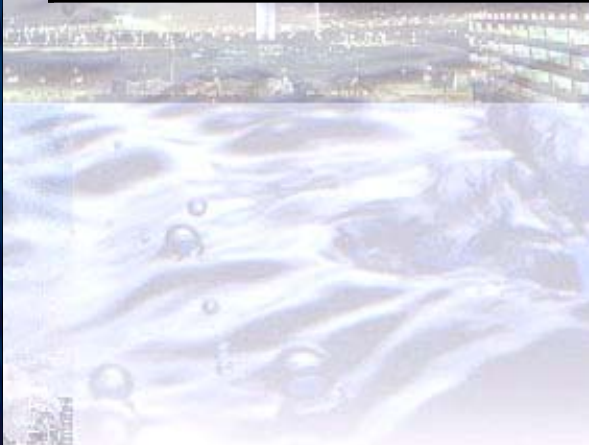
b) Typical View



DESIGN CRITERIA

DRY POND

Design Parameter	Criteria
Maximum period of Surface Water Inundation	24 hours
Maximum depth of water inundation	150 mm





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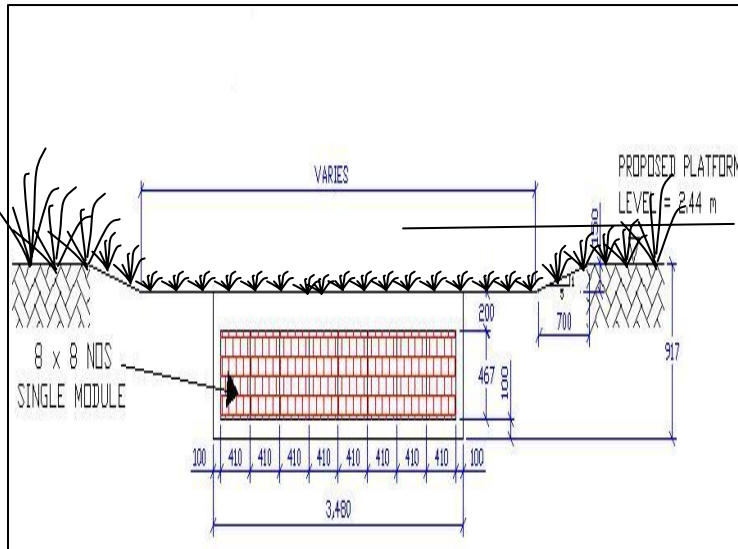
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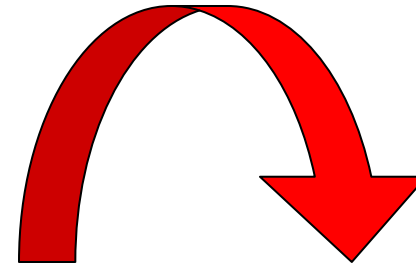
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DRY POND

a) Cross Section



b) Typical View



DRY POND



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Dry Pond

Swale

DRY POND



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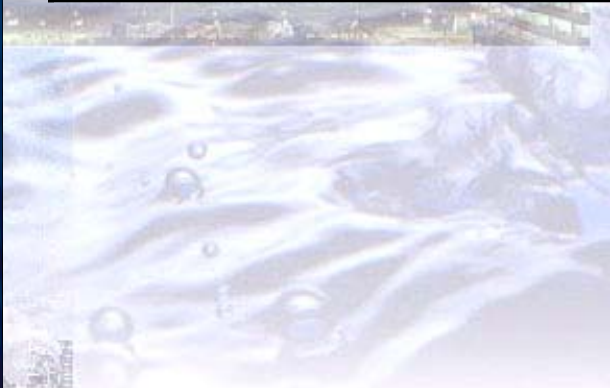
Dry Pond

Swale

DESIGN CRITERIA

WET POND

Design Parameter	Criteria
Surface Area	4500 m²
Volume Capacity	5000m³
Design Rainfall	10 year ARI



WET POND



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DESIGN CRITERIA

DETENTION POND



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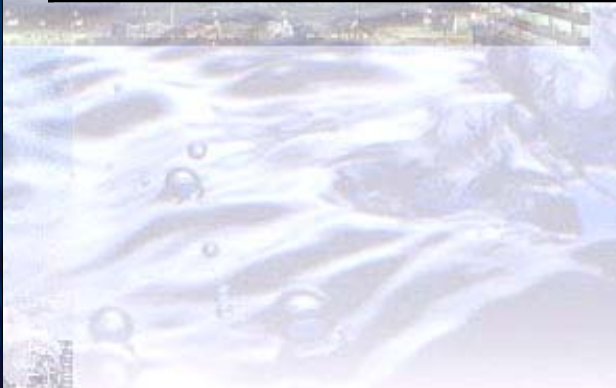
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Design Parameter	Criteria
Surface Area	10,000 m²
Volume Capacity	18,000m³
Design Rainfall	50- year ARI



DETENTION POND



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DESIGN CRITERIA FOR CONSTRUCTED WETLAND



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Design Parameter	Criteria
Catchment Area	1.214km ²
Design Storm(3 month ARI)	22.5 mm/hr
Length	155 m
Width	60 m
Wetland Surface Area	9,100 m ²
Volume	9,100 m ³
% Catchment Area	0.7
Design Inflow Rate	0.25 m ³ /s
Mean Residence Time	3 days
Slope of Wetland Bed	1%
Bed Depth	0.6 m
Media	Pea Gravel and Soil Mixture
Hydraulic Conductivity of Gravel	10 ⁻³ m/s to 10 ⁻² m/s

WETLAND PLANT SPECIES



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Type	Plant Name
Type 1(0.3 m depth)	Eleocharis Variegata
Type 2(0.3 m depth)	Eleocharis Dulcis
Type 3(0.3 m depth)	Hanguana Malayana
Type 4(0.6 m depth)	Lepironia Articularata
Type 5(0.6 m depth)	Typha Augustifolia
Type 6(1.0 m depth)	Phragmites Karka

USM WETLAND PLANT SPECIES



USM

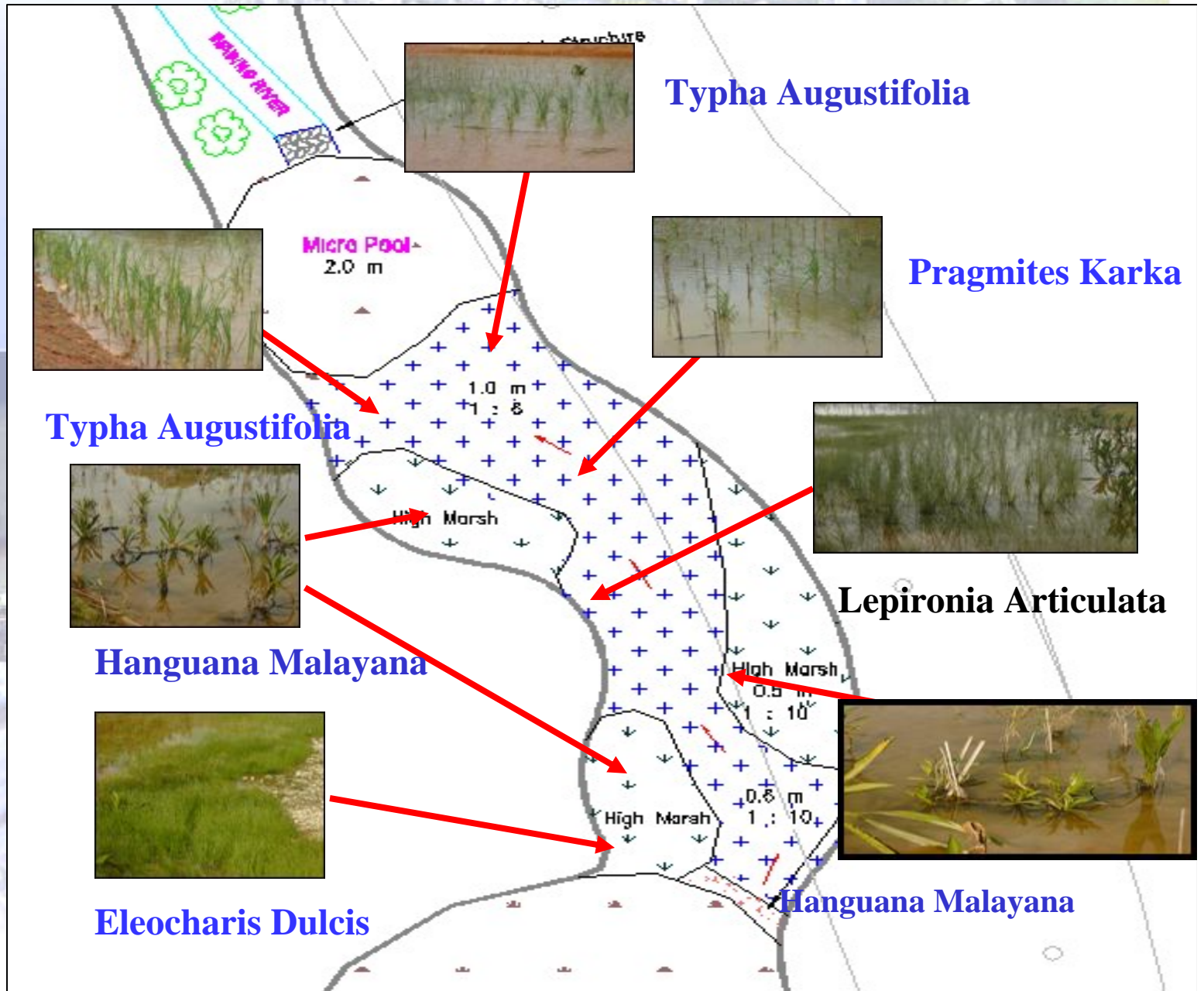
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WETLAND



WADING RIVER



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RECREATIONAL POND



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FINAL DISCHARGE TO RIVER KERIAN



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ECOLOGICAL SWALE MATERIALS



ECOLOGICAL SWALE MATERIALS



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a) Geostrip



b) Module



c) Hydronet



d) River Sand

ECOLOGICAL SWALE MATERIALS



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e) Topsoil

f) Cow Grass



ECOLOGICAL SWALE MATERIALS



Swale Components	Specifications	Details
Geostrip(parameter Swale)	Dimension	100mmx80mmx 550mm
	Flow Rate at 1% gradient	80 l/min
	Compressive Strenght	12 tons/m ²
	Material	Recycled polypropylene
Module(Ecological Swale)	Dimension	405mmx465x607mm
	Flow Rate at 1% gradient	2280 l/min
	Compressive Strenght	8 tons/m ²
	Material	Recycled Polypropylene
Hydronet Filter Fabric	Permeability	9.30 mm/s
	Screening capability	0.38mm
Clear Sand River	Sieve Analysis according to BS 1377	Mean Sisez between 0.5mm and 0.2 mm
Top Soil	Thickness	One to two inches
Grass	Species	Cow Grass



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CONSTRUCTION EXPERIENCE



CONSTRUCTION OF AN ECOLOGICAL SWALE



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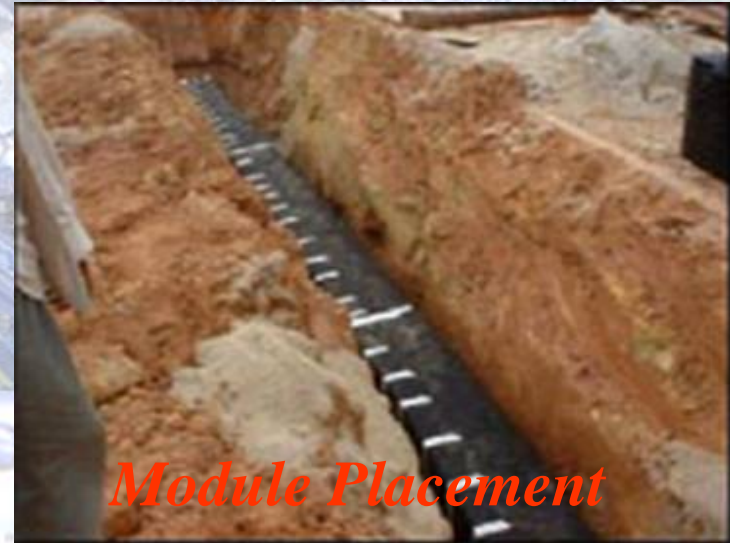
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Excavation



Module Placement



Subsurface Detention



Connection between Swale and Subsurface Detention

CONSTRUCTION OF AN ECOLOGICAL SWALE



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Sand Bedding



Grass Planting

CONCLUDING REMARKS



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- **By minimizing the surface runoff at source through the provision of on-site facilities the peak runoff can be reduced at the downstream area**
- **Water quality of Standard Class IIB can be achieved if new developments in Malaysia use the concept of Sustainable Urban Drainage System such as the Bio-Ecological Drainage System.**



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PERAKHAYAT

