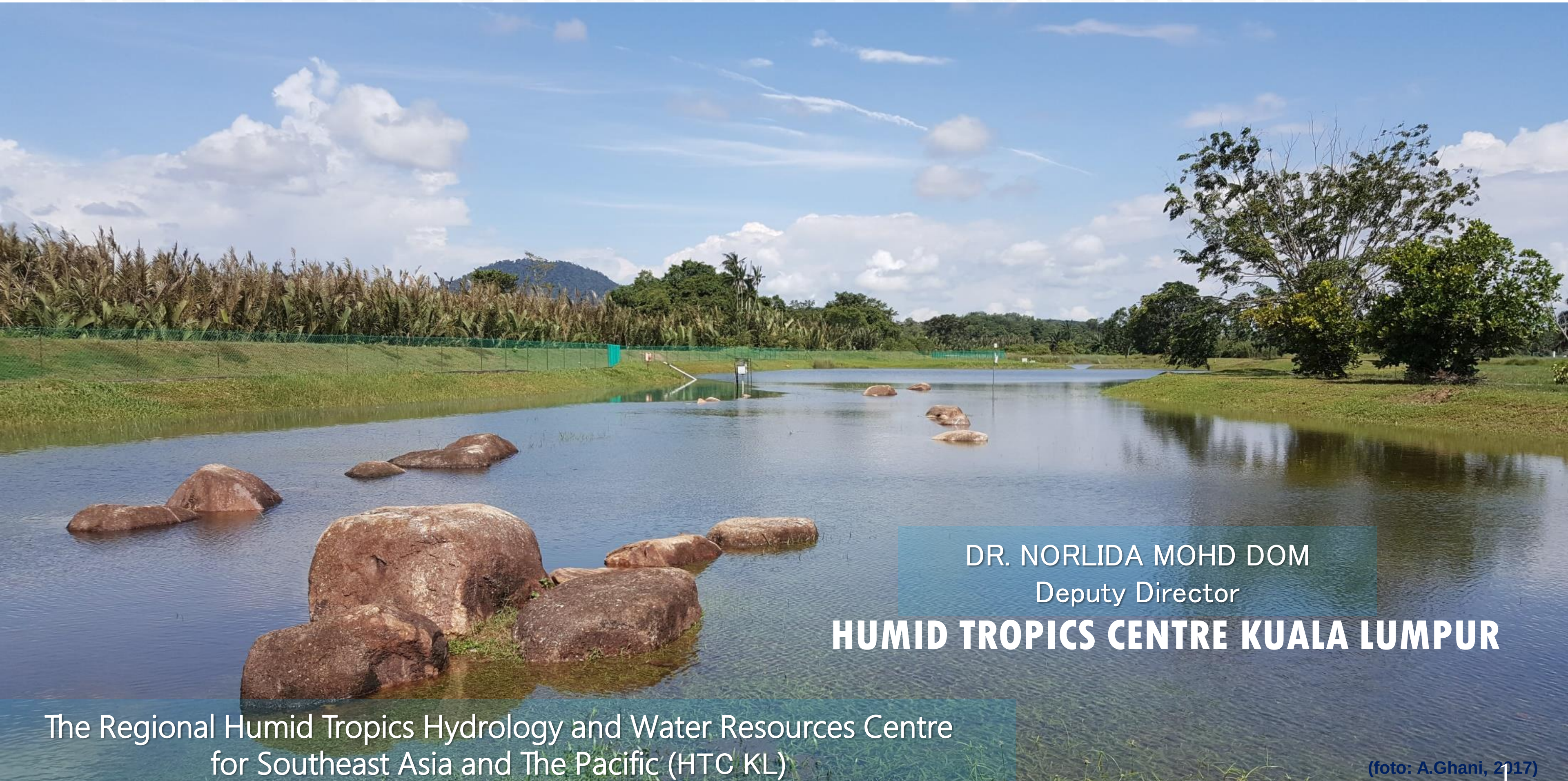
NATIONAL CONFERENCE ON STORMWATER MANAGEMENT AND EROSION & SEDIMENT CONTROL (SWaM 2017)
KUALA TERENGGANU, MALAYSIA
18 – 20 SEPTEMBER 2017

United Nations Educational, Scientific and Cultural Organization

EMERGING ECOHYDROLOGY ON URBAN STORMWATER MANAGEMENT

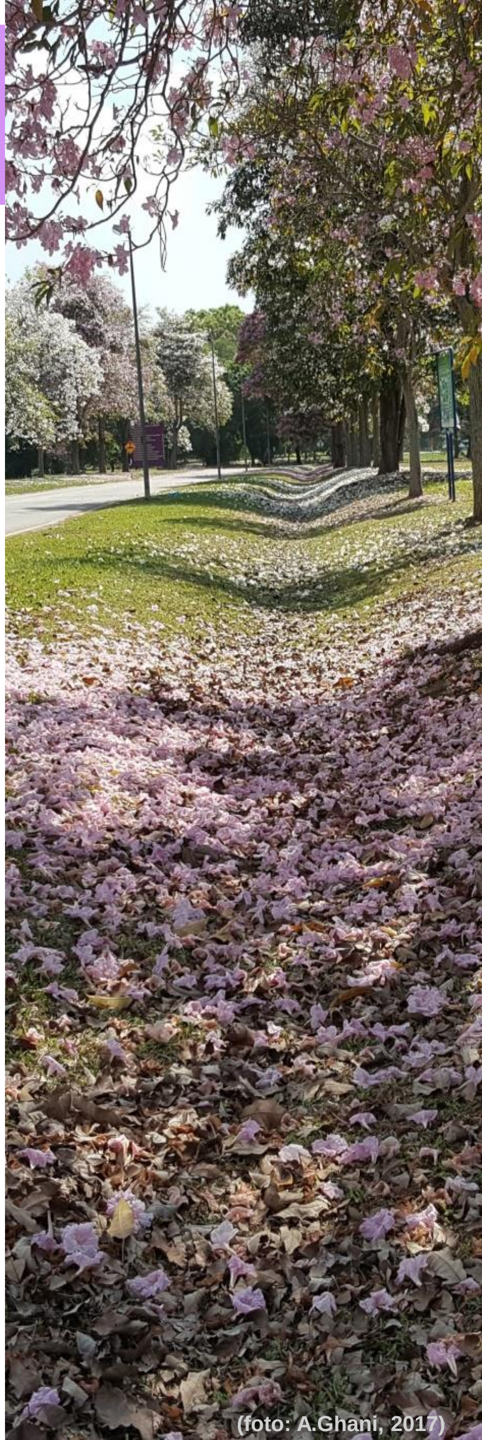


DR. NORLIDA MOHD DOM
Deputy Director
HUMID TROPICS CENTRE KUALA LUMPUR

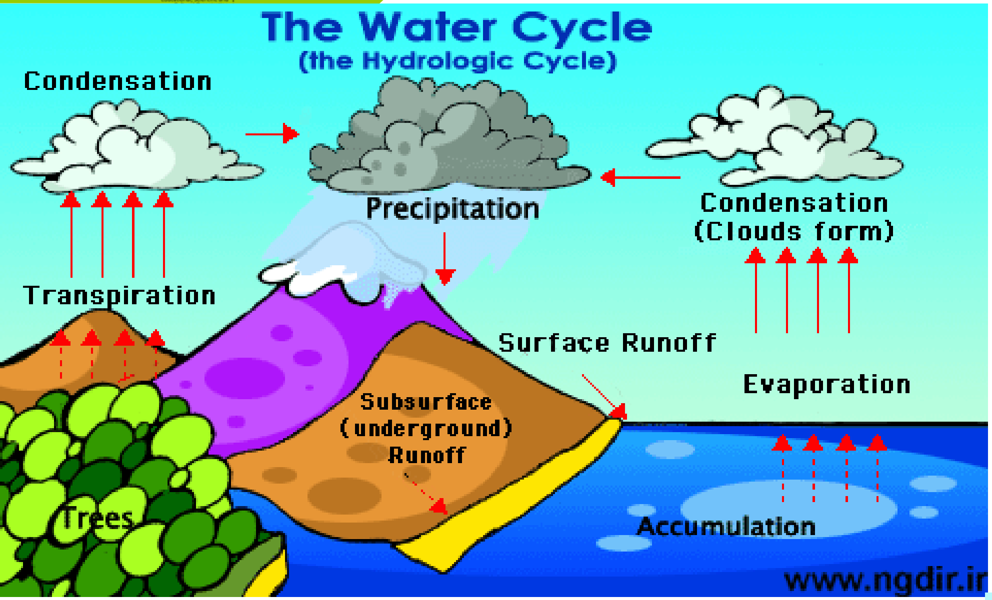
The Regional Humid Tropics Hydrology and Water Resources Centre for Southeast Asia and The Pacific (HTC KL)

(foto: A.Ghani, 2017)

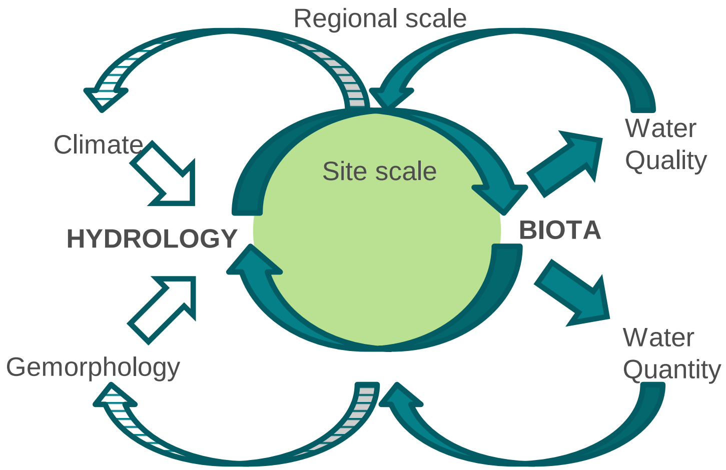
PRESENTATION OUTLINE


(foto: A.Ghani, 2017)

WATER AND ECOSYSTEMS



ECOHYDROLOGY
an interdisciplinary field studying the interactions between water and ecosystem



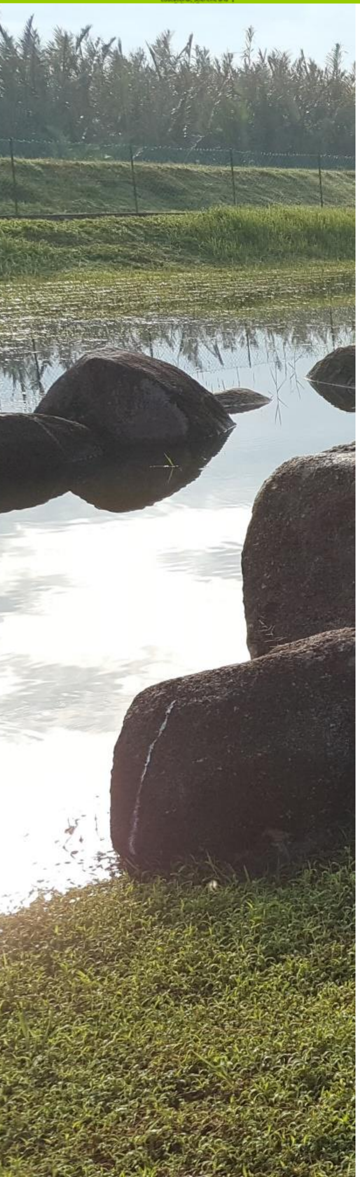
THE INTERACTIONS BETWEEN WATER AND ECOSYSTEM

PEOPLE **8%** portable water, livestock, recreation & tourism

FOOD **74%** agriculture, aquaculture

INDUSTRY **18%** power generation, development

THE PRINCIPLES OF ECOHYDROLOGY IN STORM WATER MANAGEMENT



ECOHYDROLOGY

3 sequential components:

- Hydrological
- Ecological
- Ecological engineering

Hydrological: PROCESS hydrological cycle of a basin, hydrological and biological process

Ecological: INTEGRATED processes basin scale basin's carrying capacity ecosystem services.

Ecological engineering: REGULATION of hydrological and ecological integrative approach, FOR new tool for Integrated River Basin Management.

(foto: A.Ghani, 2017)

AGENDA 2030

UN SUMMIT (25-27 SEPTEMBER 2015)
TRANSFORMING OUR WORLD
THE 2030 AGENDA FOR SUSTAINABLE DEVELOPMENT

FOR Ecohydrology

Goal 6. Ensure availability and sustainable management of water and sanitation for all

IN SWM

TRANSFORMING THE WATER SECTOR

Malaysia

National IWRM Plan
Strategies & Road Map"**Goal 6**" (ASM, 2017)

6.1 By 2030, achieve universal and equitable access to safe and affordable drinking water for all

6.2 By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations

6.3 By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally

6.4 By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity

6.6 **By 2020, protect and restore water-related ecosystems,including mountains, forests, wetlands, rivers, aquifers and lakes**

6.5 By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate

6.6 **By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes**

6.a By 2030, expand international cooperation and capacity-building support to developing countries in water- and sanitation-related activities and programmes, including water harvesting, desalination, water efficiency, wastewater treatment, recycling and reuse technologies

6.b Support and strengthen the participation of local communities in improving water and sanitation management

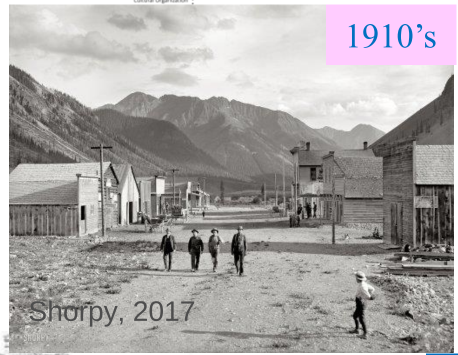
(source: ASM, 2017)

SWM FOR IWRM

EcoHydrology
STORM WATER MANAGEMENT

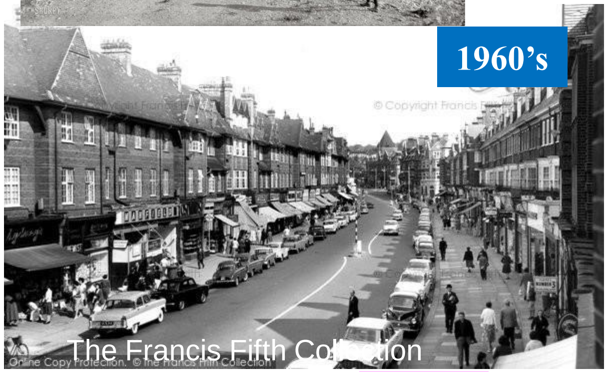
(foto: A.Ghani, 2017)

STORMWATER MANAGEMENT EVOLUTION 1910’s TO 2011


Shorpy, 2017

1910’s

- Lack of mandatory service standards and infrastructure planning


The Francis Fifth Collection

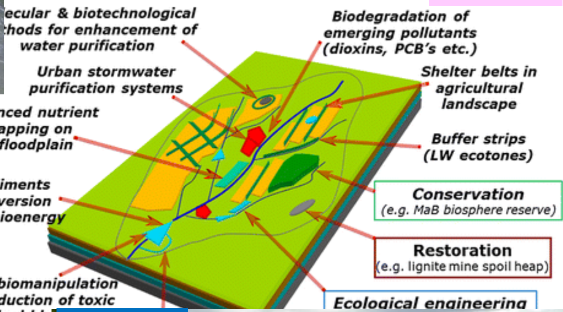
1960’s

- Engineering solutions to historical problems

2010’s

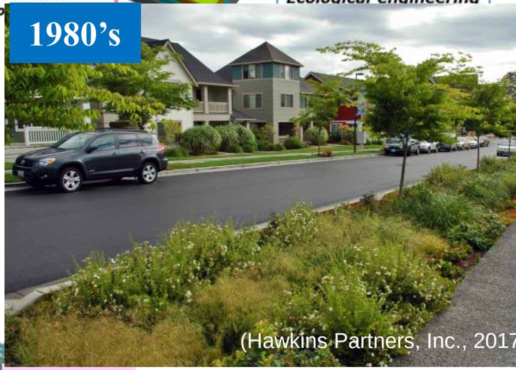
- IHP VIII (2014-2021) Water Security: Responses to Local and Global Challenges. incorporating medium-term strategies

2000’s



- Total water cycle management - integrated water resource management

1980’s


(Hawkins Partners, Inc., 2017)

- Sustainable Urban Drainage Systems

1970’s

- Drainage and flood protection standards introduced, Rapid disposal, Conveyance Oriented

1980’s


River Aire constructed in the 1930s (ResearchGate, 2017)

1980’s

- Treating stormwater to improve water quality

- River Restoration / rehabilitation (- Soft engineering solutions)

STORMWATER SYSTEMS

Rainwater Harvesting

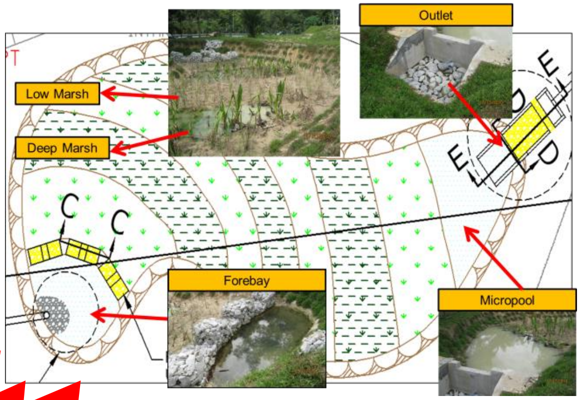
Non-vegetated systems

- Roofwater harvesting systems
  - Conventional
  - Siphonic
- Rainwater tanks
- Permeable pavements
- Managed aquifer recharge

Filtered pollutant
Tc Delayed

Vegetated Systems

- Large-scaled system
  - Wetlands
  - Ponds
- Small-scaled systems
  - Bioretention basins
  - Biofiltration swales



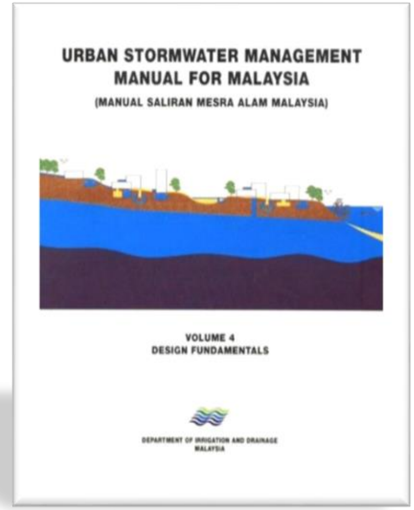
Integrated systems

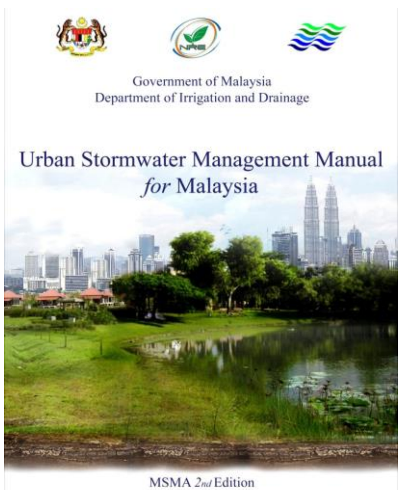
- Permeable pavement draining to biofiltration swale draining to wetland

POLLUTANT REDUCTION

Pollutant	New Development	Land Redevelopment (see note)	Drainage System Upgrading
	Annual Average Pollutant Removal Efficiency (%)	Reduction in Annual Average Pollutant Load from Existing Conditions (%)	Reduction in Annual Average Pollutant Load from Existing Conditions (%)
Floatables	90	90	30
Sediment	70	50	20
Suspended Solids	60	40	20
Nitrogen	50	30	20
Phosphorus	50	30	20

Table 4.5 Pollutant Retention or Load Reduction Targets , MSMA 1ST EDITION





MSMA 2ND EDITION

(Table 3.12: Pollutant Reduction Targets -DID, 2011)

POST-DEVELOPMENT

Pollutant	Annual Reduction Targets (%)
Floatables/Litters	90
Total Suspended Solids (TSS)	80
Total Nitrogen (TN)	50
Total Phosphorus (TP)	50

EMC

Design ARI

Typical urban catchment in Malaysia, the recommended design ARI for quality control structure is 3 month ARI.

Parameter	Event Mean Concentration (EMC)			
	Residential	Commercial	Industrial	Highway
TSS	128mg/l	122mg/l	166mg/l	80mg/l
TP	0.34mg/l	0.32mg/l	0.49mg/l	0.16mg/l
TN	4.21mg/l	4.84mg/l	5.00mg/l	2.25mg/l

MSMA 2nd Edition

MALAYSIA CASE STUDIES

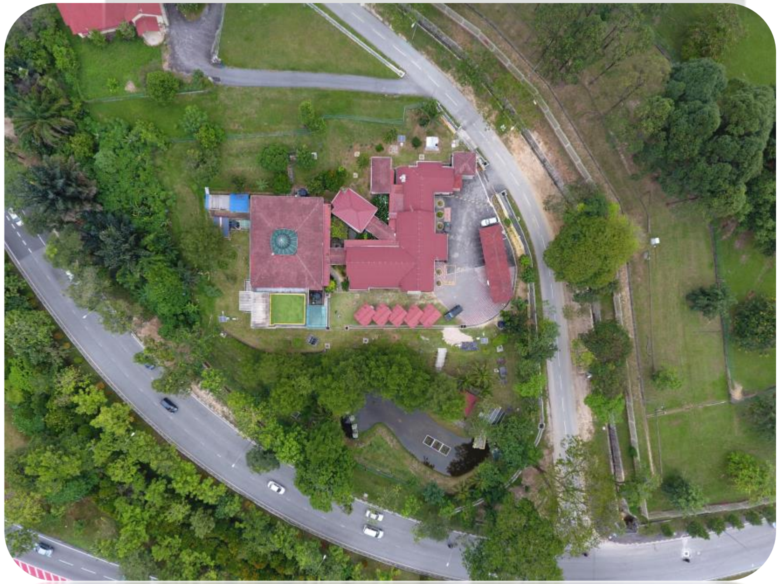
DESKTOP

SUNGAI LANGAT

IMPLEMENTATION

USM BIOECODES

IMPLEMENTATION

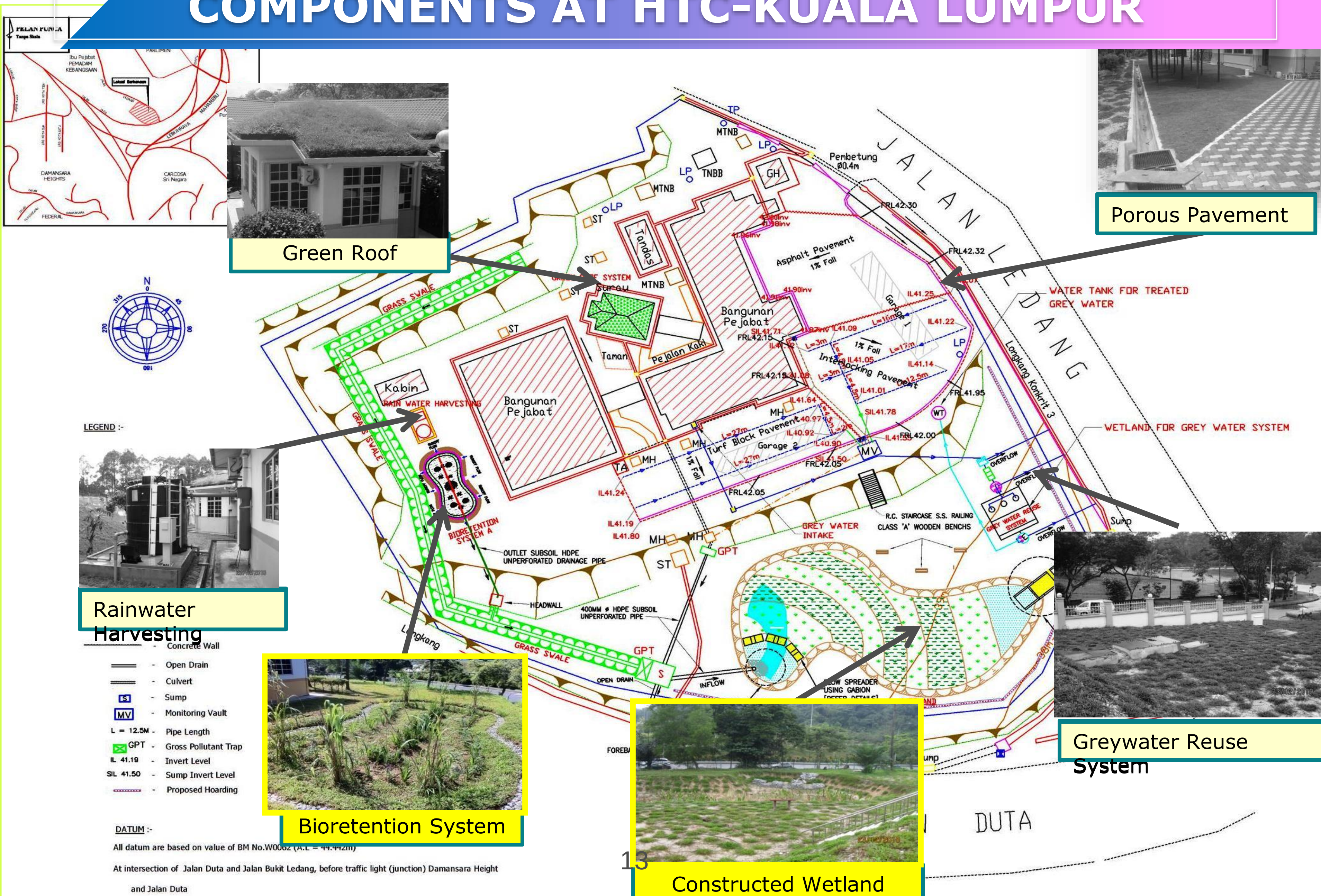


HUMD TROPICS CENTRE KL- MSMA SME

IMPLEMENTATION

PUTRAJAYA WETLAND

STORMWATER ECOHYDROLOGY (SME) COMPONENTS AT HTC-KUALA LUMPUR

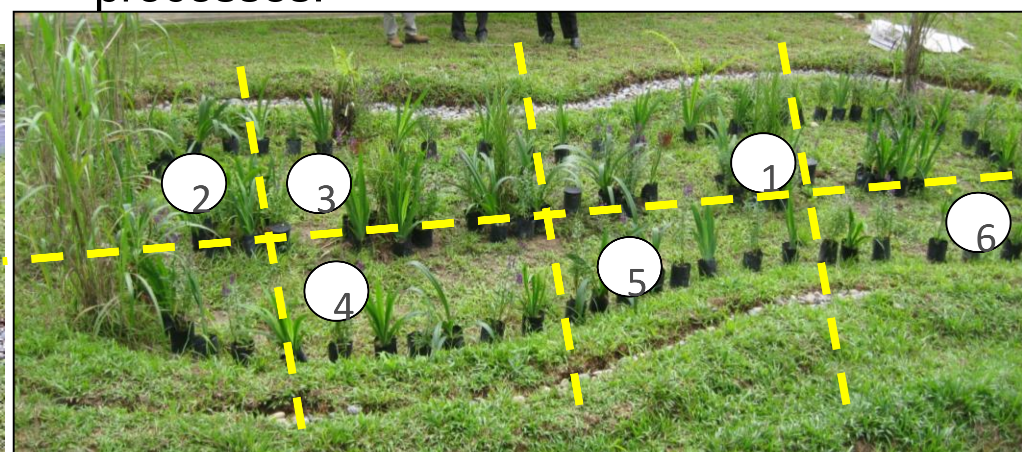


MSMA Components

MSMA SME Components: Bioretention

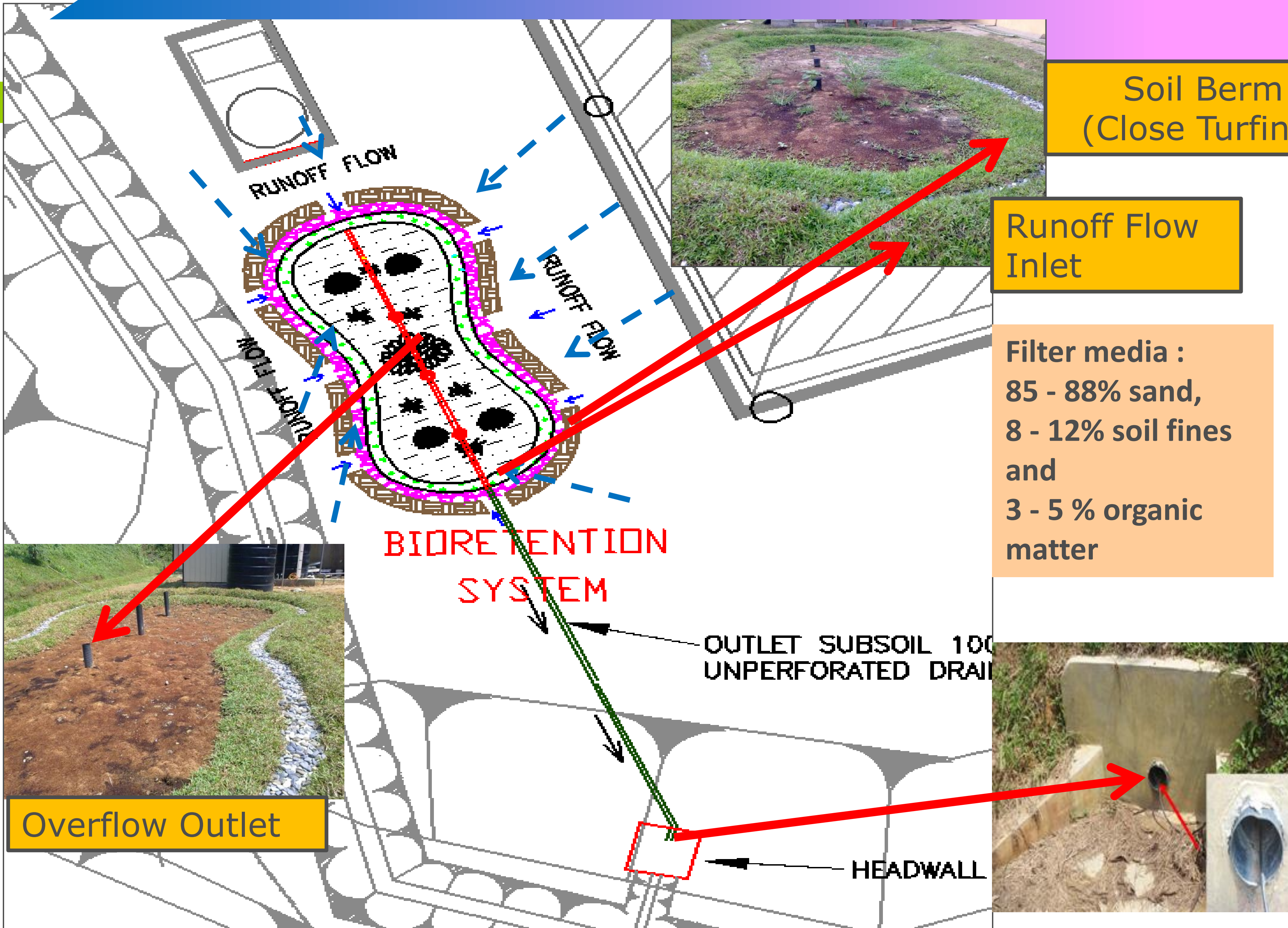
- Bioretention basins are landscaped depressions or shallow basins used to slow and treat on-site stormwater runoff.
- Stormwater is directed to the basin and then percolates through the system where it is treated by a number of physical, chemical and biological processes.

Bioretention at HTC Kuala Lumpur



Grid and points opted for hydraulic conductivity test at bioretention cell

BIORETENTION CONSTRUCTION



Filter media :
85 - 88% sand,
8 - 12% soil fines
and
3 - 5 % organic
matter

HYDRAULIC CONDUCTIVITY OF THE FILTER MEDIA AT BIORETENTION SYSTEM

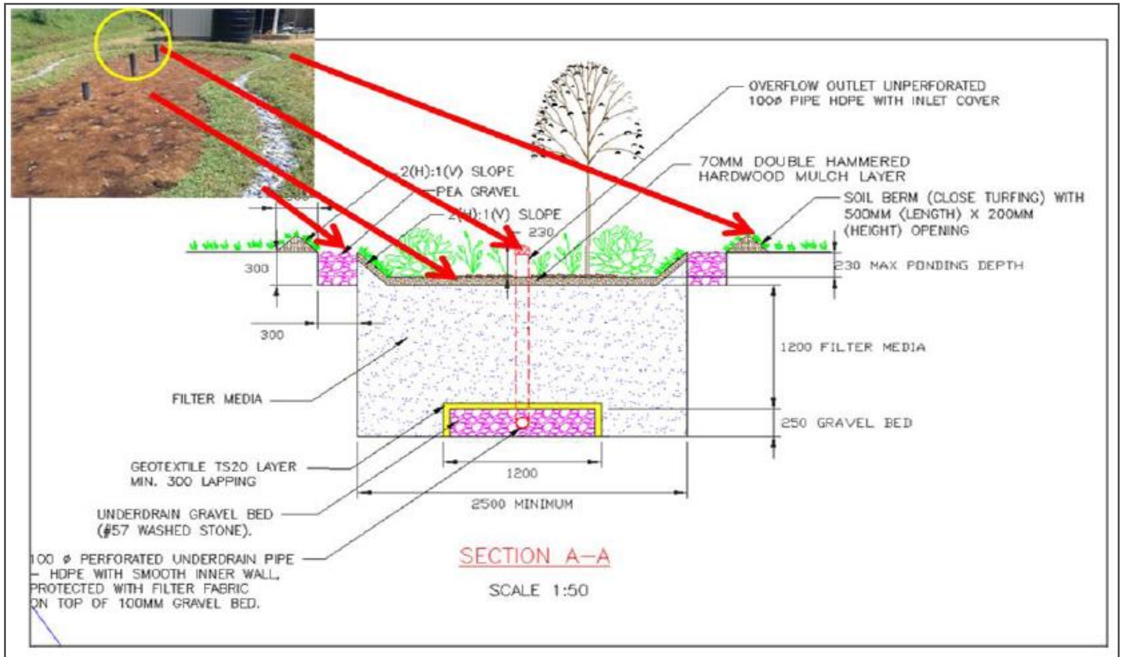
Testing Point	Initial Rate of Infiltration (f_0) (mm/hr)	Constant Rate of Infiltration (f_c) (mm/hr)	Shape Factor (k) (hr^{-1})	Horton Equation $f = f_c+(f_0 - f_c)e^{-kt}$
Before Installation of Bioretention	62.15	3	5.86	$f = 3 + (62.15 - 3)^{e-5.86t}$
With Bioretention				
Point 1	280.75	76.36	6.37	$f = 76.36 + (280.75-76.36)^{e-6.37t}$
Point 2	155.51	48.87	6.83	$f = 48.87 + (155.51-48.87)^{e-6.83t}$
Point 3	234.93	30.55	6.84	$f = 30.55 + (234.93-30.55)^{e-6.84t}$
Point 4	292.97	88.58	12.36	$f = 88.58 + (292.97-88.58)^{e-12.36t}$
Point 5	311.29	106.91	5.93	$f = 106.91 + (311.29-106.91)^{e-5.93t}$
Point 6	296.02	91.63	0.355	$f = 91.63 + (296.02-91.63)^{e-0.355t}$

The constant infiltration rate was recorded at 3 mm/hr which is ten (10) thirty five (35) times lower than the constant infiltration rate taken during hydraulic conductivity test on the bioretention system.

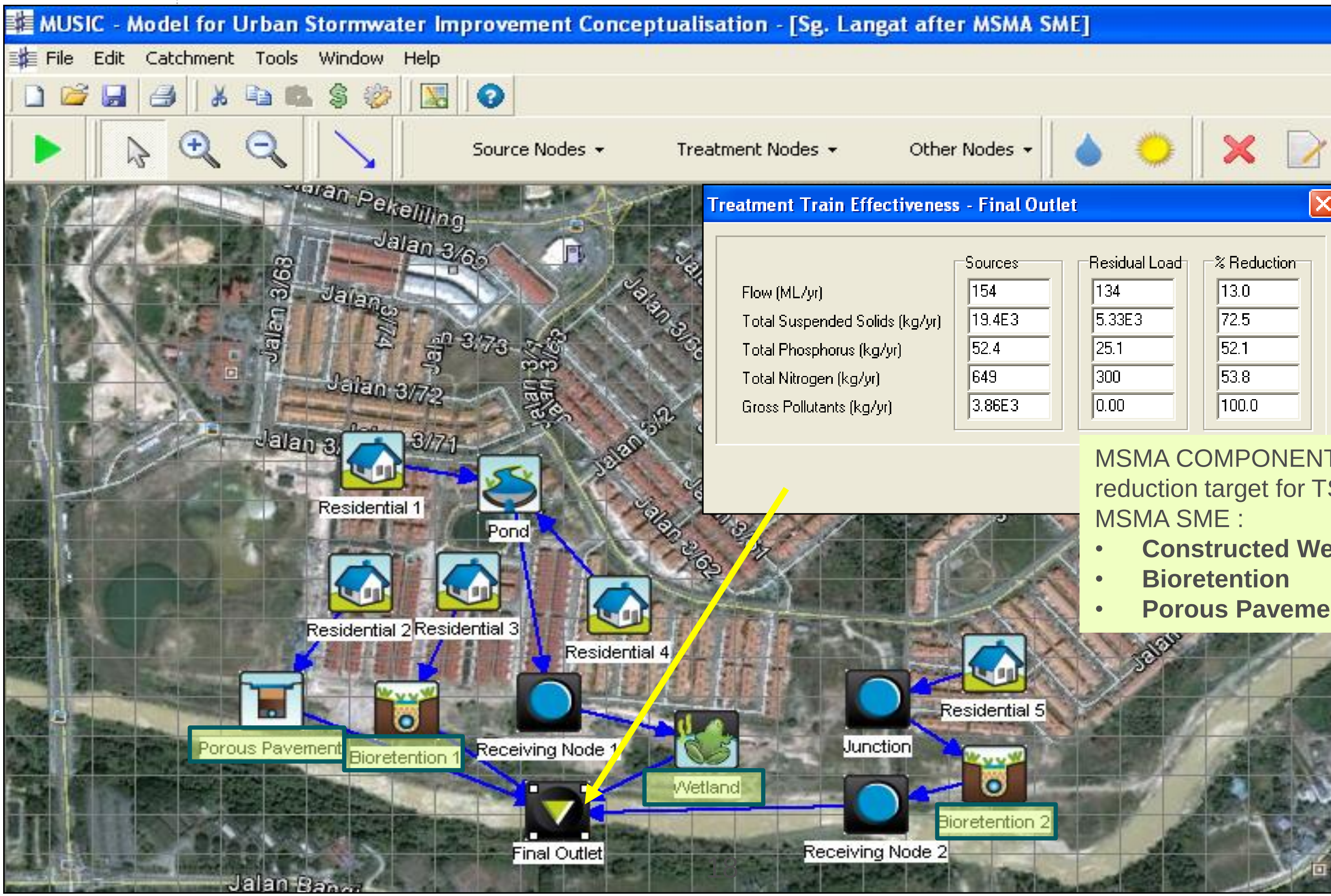
RESULTS & ANALYSIS

Event	Event length (min)	Total rainfall (mm)	Rainfall intensity (mm/hr)			Total inflow (m^3)	Total outflow (m^3)	*Bioretention* (m^3)
			5-min	1-hr	24-hr			
8/7/2012	103	23.4	24.0	22.6	1.0	0.772	0.046	0.726
9/7/2012	251	15.0	7.2	5.4	0.6	0.495	0.004	0.491
16/7/2012	66	42.6	7.2	40.2	1.8	1.406	0.016	1.390
17/7/2012	121	10.0	19.2	8.6	0.4	0.330	0.091	0.239

91% REDUCTION/ STORAGE BACK TO GROUNDATER



SUNGAI LANGAT @ BANGI



MSMA COMPONENT Load reduction target for TSS, TN, TP, MSMA SME :

- **Constructed Wetland**
- **Bioretention**
- **Porous Pavement**

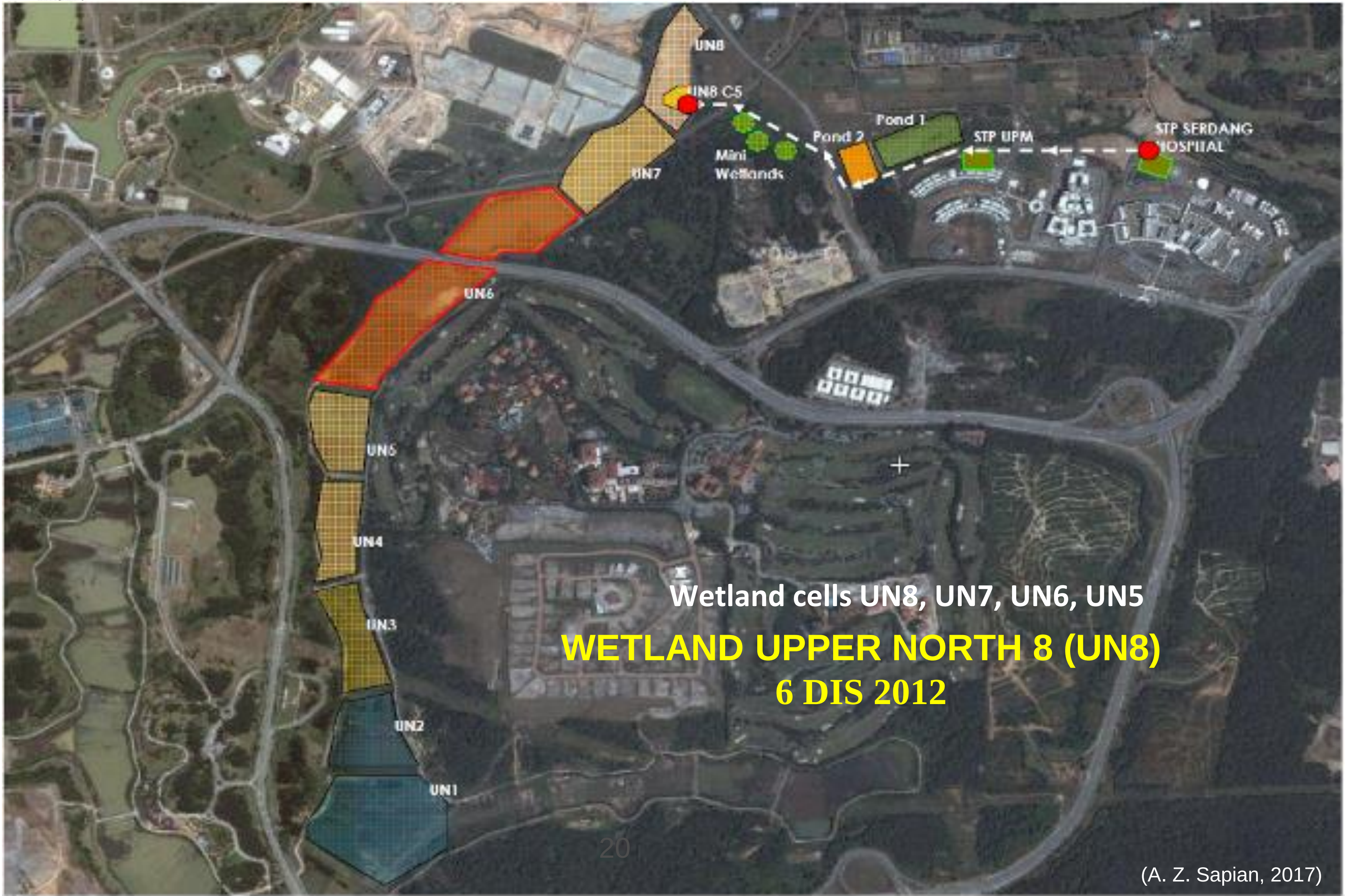
SUNGAI LANGAT @ BANGI

MUSIC Pollutant Reduction Model Results (With & Without MSMA-SME Components)

ANNUAL % POLLUTANT REDUCTION RESULTS

Catchment	Sources	Residual Load	% Reduction	% Reduction
Receiving Node 1				
Flow (ML/yr)	86.6	79.8	7.9	0
TSS (kg/year)	10.9E3	1.22E3	88.8	0
TP (kg/year)	29.4	7.98	72.9	0
TN (kg/year)	364	160	56.0	0
Gross Pollutant (kg/year)	2.17E3	0	100.0	0
Receiving Node 2				
Flow (ML/yr)	19.7	19.2	2.6	0
TSS (kg/year)	2.48E3	813	67.2	0
TP (kg/year)	6.70	5.83	12.9	0
TN (kg/year)	82.9	54.3	34.6	0
Gross Pollutant (kg/year)	493	0	100	0
Final Outlet				
Flow (ML/yr)	154	134	13.0	0
TSS (kg/year)	19.4E3	5.33E3	72.5	0
TP (kg/year)	52.4	25.1	52.1	0
TN (kg/year)	649	300	53.8	0
Gross Pollutant (kg/year)	3.86E3	0	100	0

PUTRAJAYA WETLAND



(A. Z. Sapian, 2017)

PUTRAJAYA WETLAND

Wetland Cells - UN8, UN7, UN6, UN5 (2011-2012)

USM ENGINEERING CAMPUS THE BIOECODES

A. Gani & M.K. ZainalFikry, 2017

WHY WE DO ALL THESE ?....

INCORPORATING MEDIUM-TERM STRATEGIES

IHP PHASE VIII (2014-2021)

Water-related Disasters and Hydrological Change

Groundwater in a Changing Environment

Addressing Water Scarcity and Quality

Water and Human Settlements of the future

Ecohydrology, Engineering Harmony for a Sustainable World

Water Education, Key for Water Security

Water Security: Response to Local, Regional, and Global Challenges

CONCLUSION

WATER FOR LIVELIHOOD
AND
WATER AS A RESOURCE

FUTURE CHALLENGE

ECOHYDOLOGY
ENFORCEMENT

Thank You

The Regional Humid Tropics Hydrology and Water Resources Centre for Southeast Asia and The Pacific
(HUMID TROPICS CENTRE KUALA LUMPUR)
No. 2, Jalan Ledang off Jalan Duta,
50480 Kuala Lumpur
Tel 603 20958700 Fax 603 20953366
Email : norlidamd@water.gov.my
norlidamd1@gmail.com