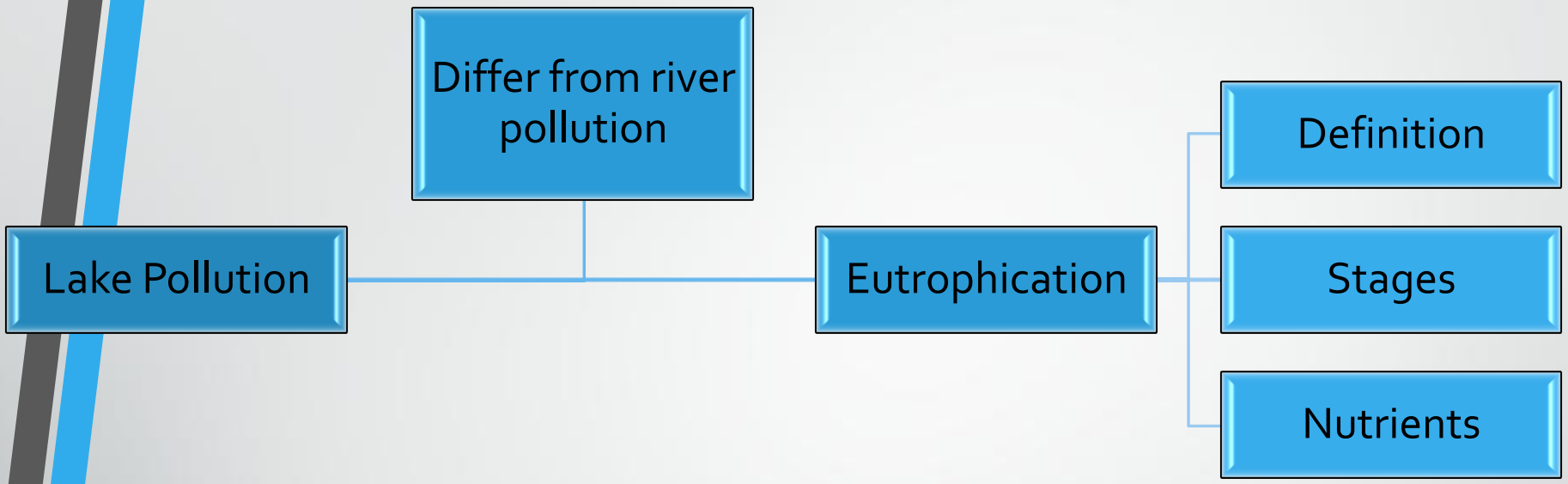
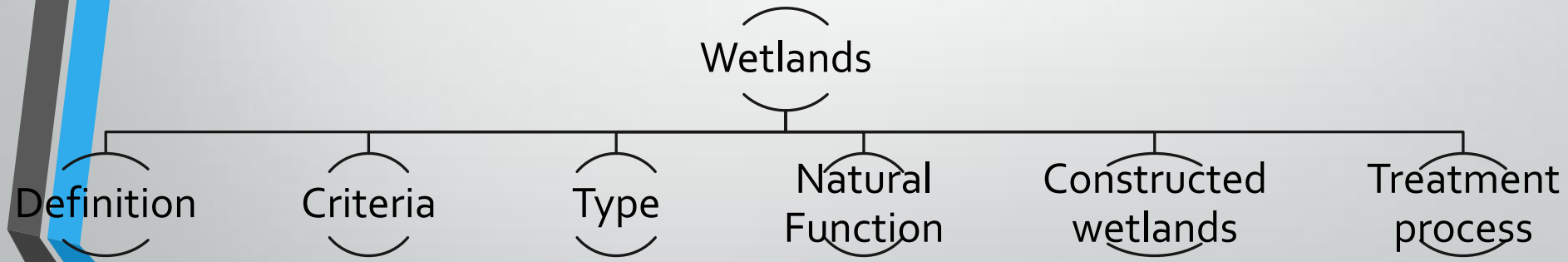
SKAA3913 ENVIRONMENTAL MANAGEMENT

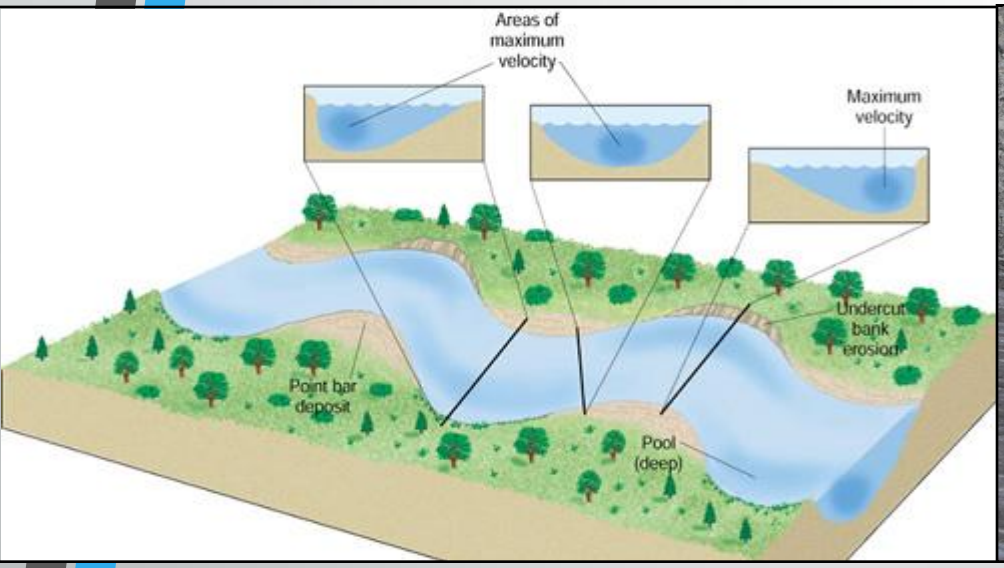
Water Pollution : Control & Regulation

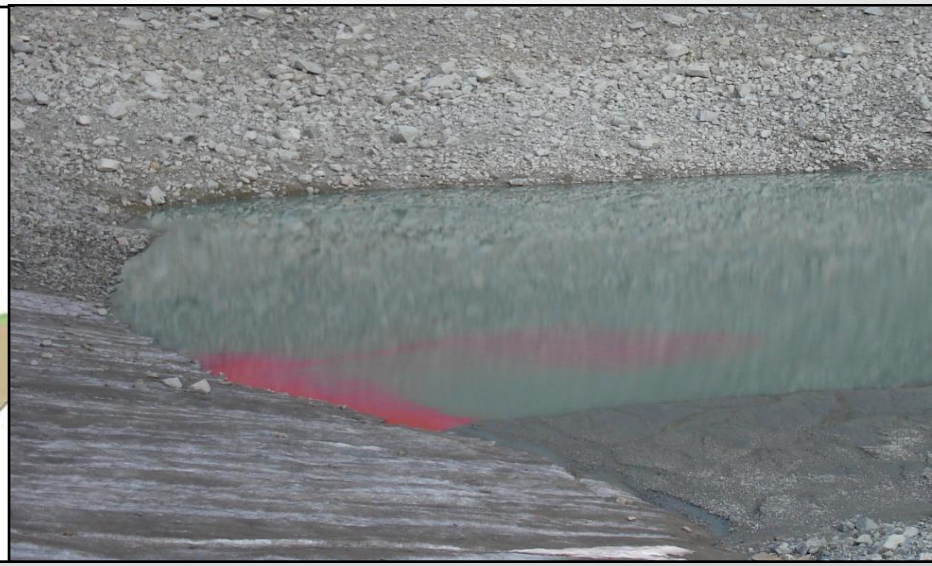

Lake Pollution
Differ from river pollution
Eutrophication
Definition
Stages
Nutrients


Wetlands
Definition
Criteria
Type
Natural Function
Constructed wetlands
Treatment process

LAKE POLLUTION

- Differs from river or stream pollution due to physical characteristics of the water mass





Water in streams or rivers is constantly moving thus providing flushing action for incoming pollutants.

- Water in lakes does not move much and retained for a long period of time. Largely influenced by the nutrients.

SHORT VIDEO ON LAKE POLLUTION AT LAKE NEWPORT, OHIO

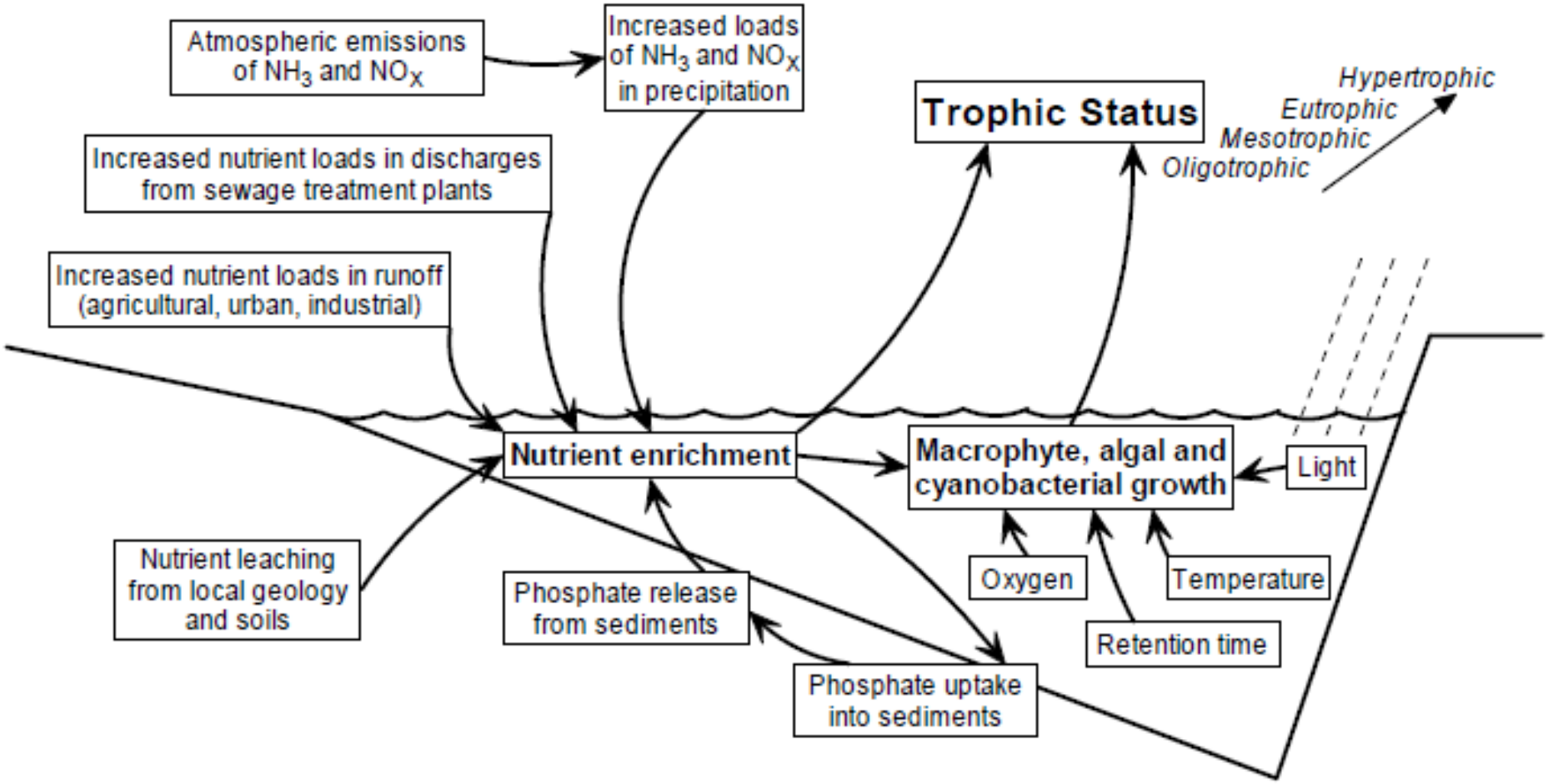
LAKE POLLUTION (CONT')

- The predominant source of lake area pollution is through nonpoint source pollution which is generated from urban runoff or simply blow into the water.

- Lake eutrophication is one of the most widespread environmental problems of inland waters, and is their unnatural enrichment with two plant nutrients, phosphorus and nitrogen.

LAKE EUTROPHICATION: DEFINITION

- Eutrophication is a process in which there is increasing anaerobic decomposition caused by an algal bloom that is triggered by accumulation of nitrates and phosphates in water, resulting in a water habitat that cannot sustain life
- Eutrophication is the natural ageing process of lakes caused by sediment input and nutrient enrichment through runoffs that carry down overused fertilizers from agro-ecosystems and/or discharged human waste from settlements.

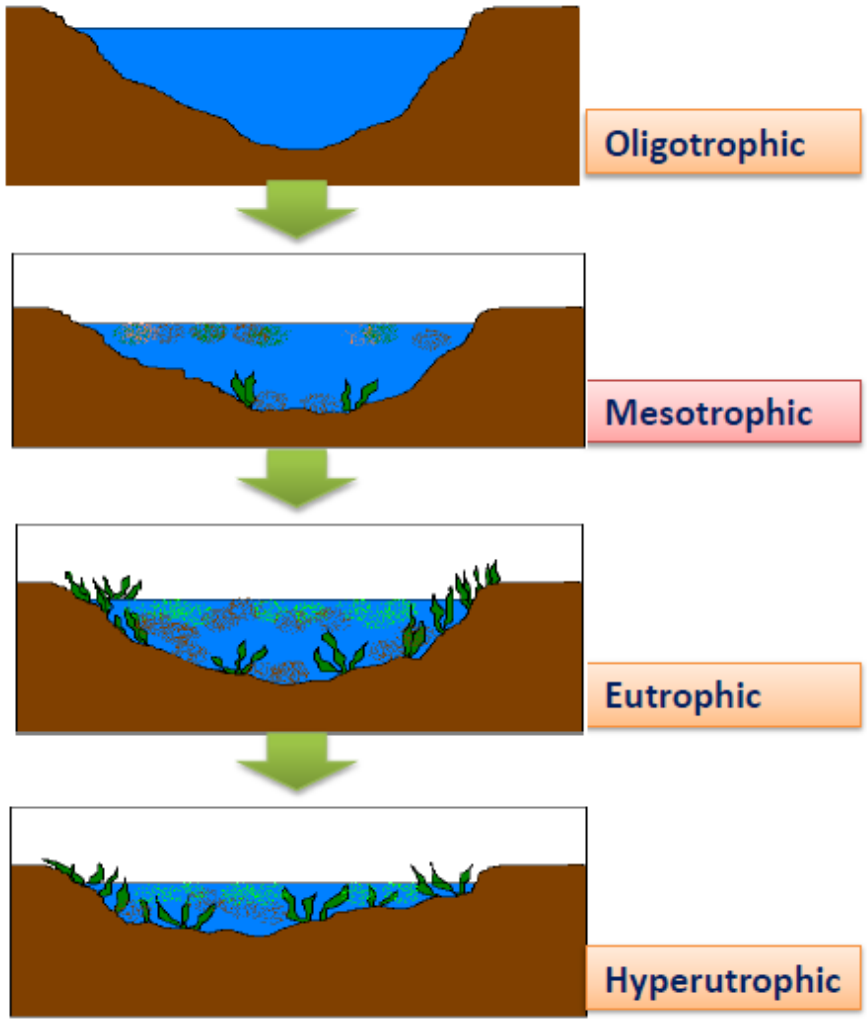


Simplified schematic illustration of the most important factors driving the eutrophication process

SHORT VIDEO ON EUTROPHICATION

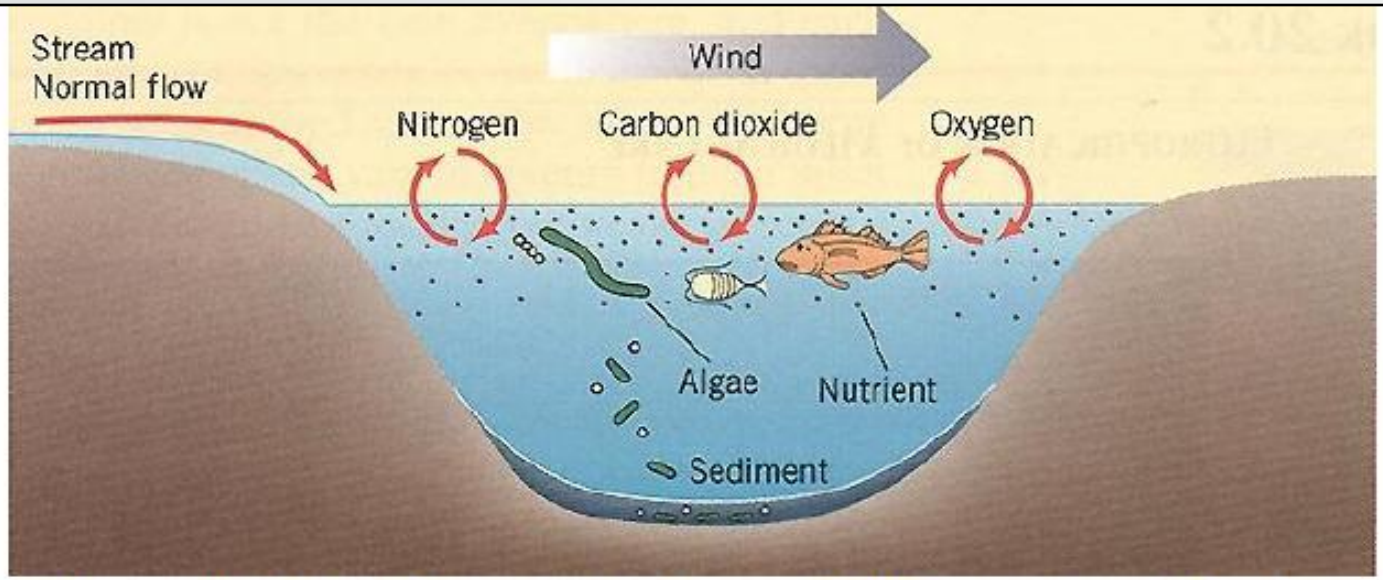
STAGES OF LAKE EUTROPHICATION

Divided into **four levels** of trophic states:



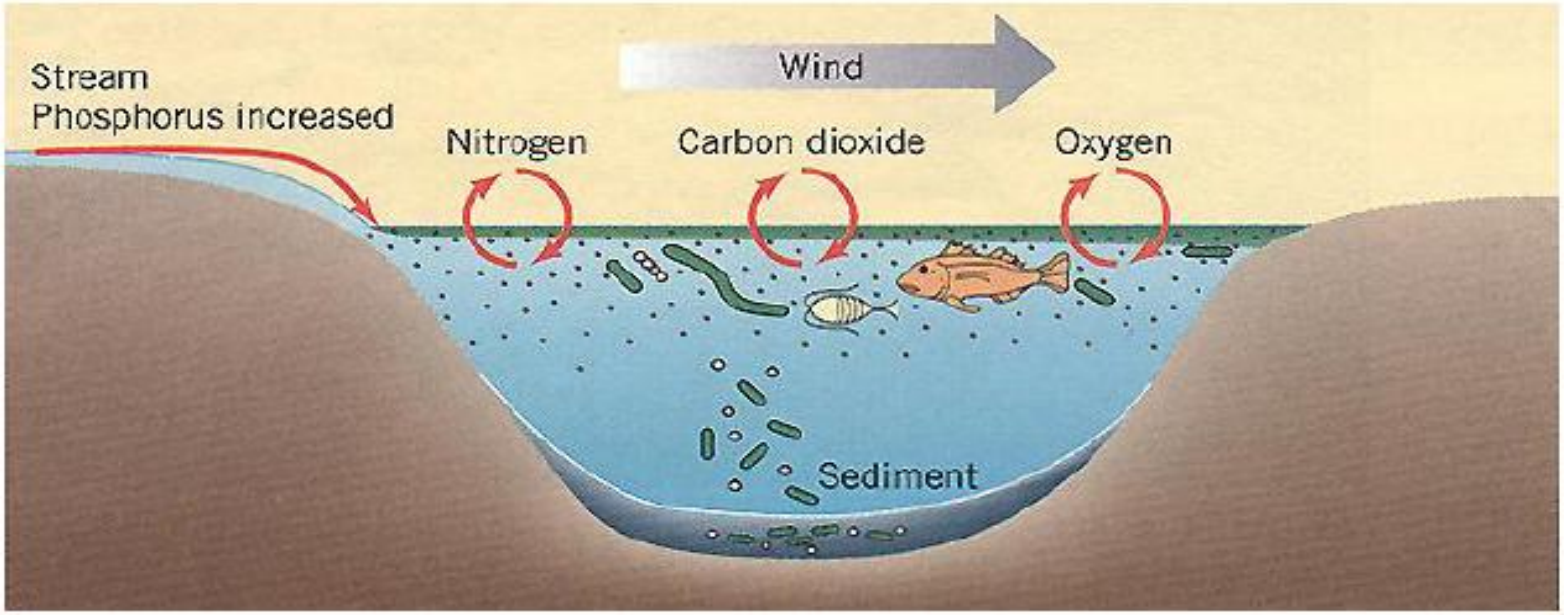
- **Oligotrophic**
  - Low nutrients and "productivity;" usually high clarity
- **Mesotrophic**
  - Moderate nutrients, "productivity" and clarity
- **Eutrophic**
  - high nutrients and "productivity;" low clarity
- **Hyperutrophic/scenecent**
  - swamp

STAGE 1 : OLIGOTROPHIC



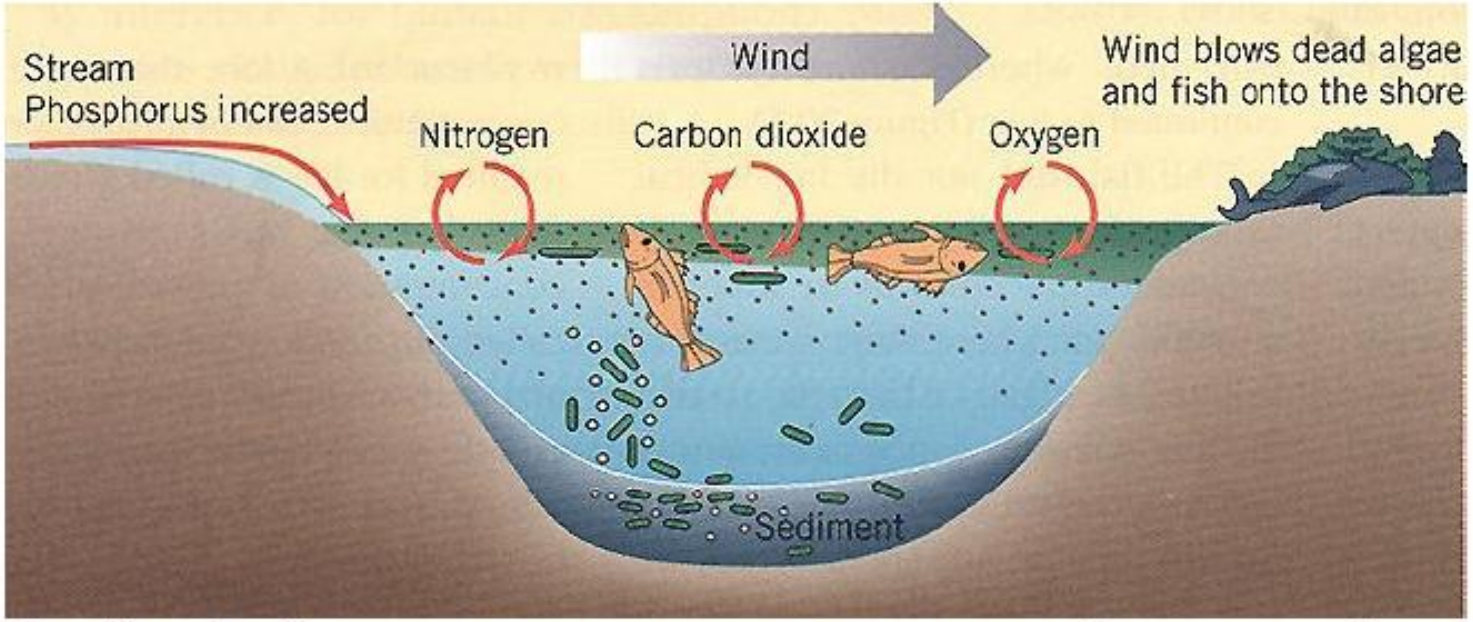
- Large deep lake with crystal clear water
- Steep shoreline and bottom gradient
- Low nutrient enrichment
- Little planktonic and rooted plant growth
- Few aquatic plants
- Sand or rock along most of shoreline
- Coldwater fishery
- High dissolved oxygen content

STAGES 2: MESOTROPHIC



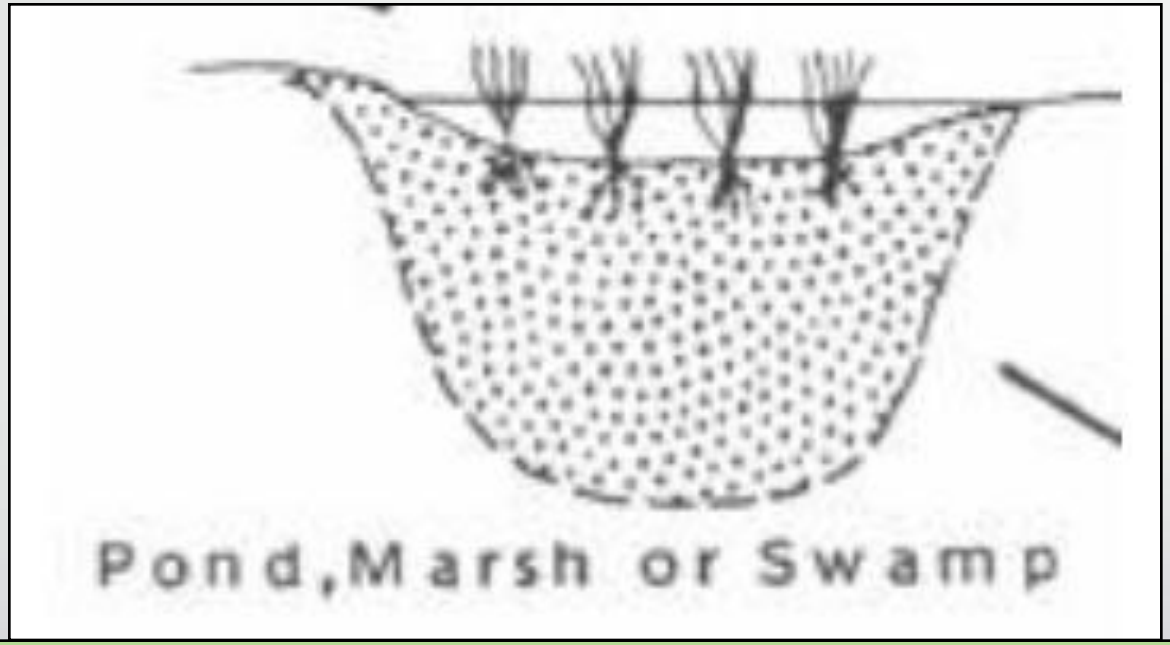
- Moderate nutrient enrichment
- Moderate planktonic growth
- Some sediment accumulation over
- Most of lake bottom
- Usually supports warm water fish species

STAGES 3: EUTROPHIC



- Typically shallow
- Low dissolved oxygen
- High nutrient enrichment
- Much planktonic growth
- Rooted plant abundant along the shore and out into lake
- Extensive aquatic plant beds
- Much sediment accumulation on bottom
- Only warm water fish species
- Water clarity is not good and often has a tea color.

STAGES 4: HYPERTROPHIC



- Closest to the wetland status / swamp
- Frequent and severe nuisance algal blooms
- Water with low transparency
- Highly productive water

NUTRIENTS AS ALGAL GROWTH REQUIREMENTS

Carbon

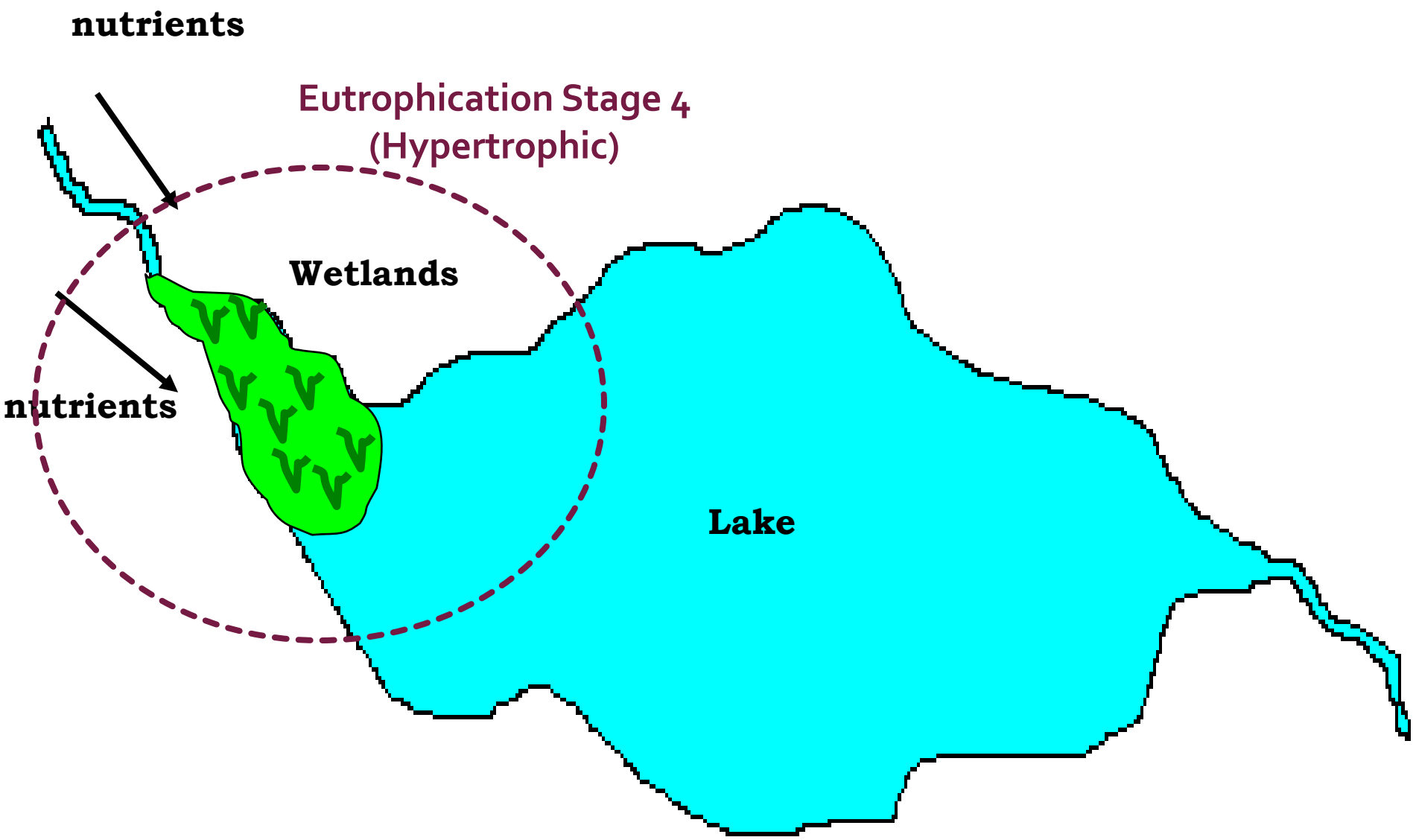
- Algae can obtain carbon from CO_2 dissolved in the water. The largest source of CO_2 is **from atmosphere**.

Nitrogen

- Usually in the form of nitrate and comes from **external sources.**

Phosphorus

- Phosphorus in lakes originates from **external sources** and is taken up by algae in the organic form.


nutrients
Eutrophication Stage 4
(Hypertrophic)
Wetlands
nutrients
Lake

WETLANDS

Ramsar Convention 1971

- Areas of marsh, peatland, or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh brackish or salt, including areas of marine water the depth of which at low tide does not exceed 6 meters

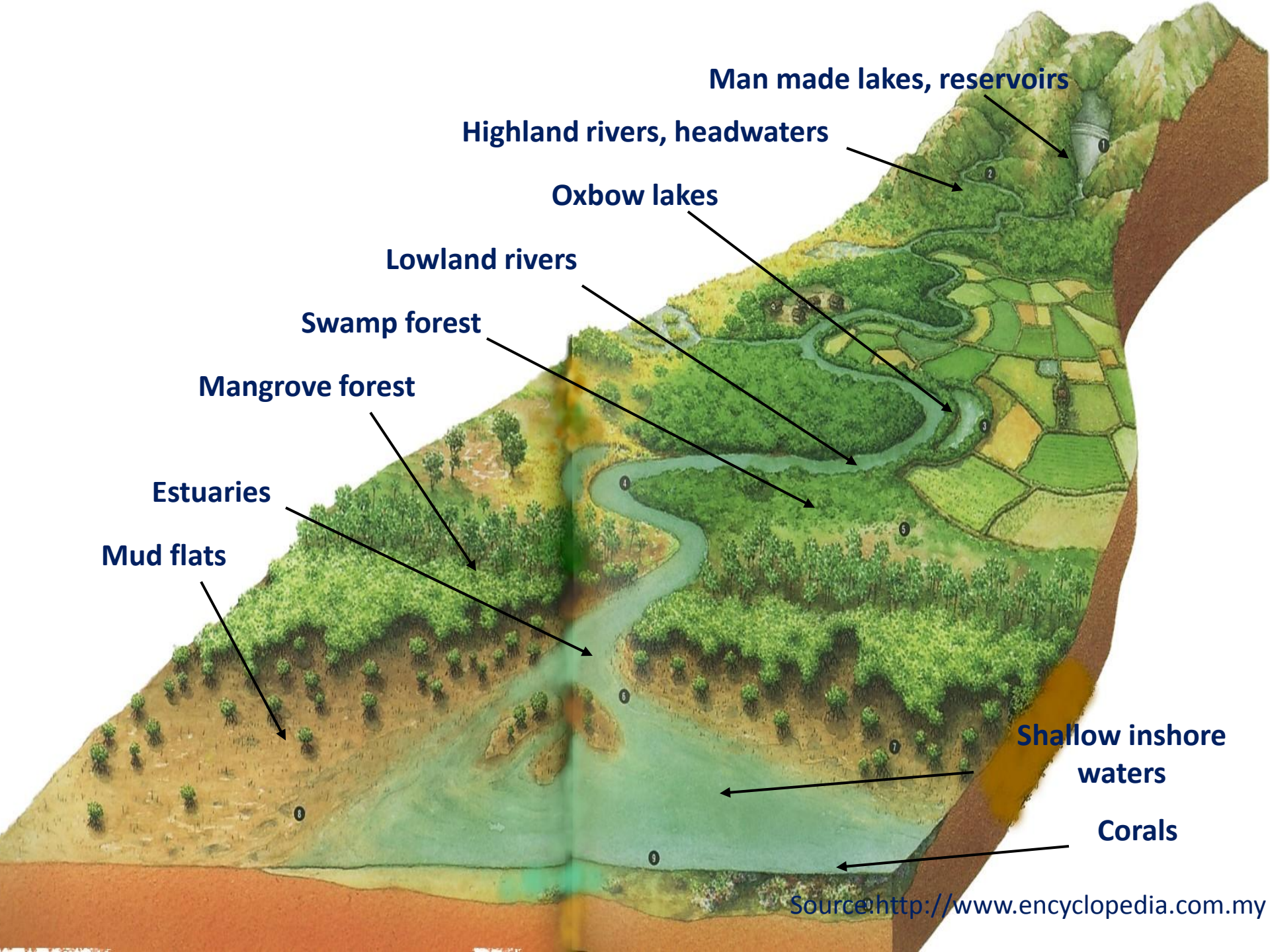
Biological definition

- Transition zone between terrestrial and aquatic environments

WHAT IS WETLAND ??

CRITERIA OF WETLANDS

- The area must be permanently or seasonally inundated
- The area must support hydrophytic vegetation
- Soil in the area must be water logged for a sufficient time to become anaerobic


Man made lakes, reservoirs
Highland rivers, headwaters
Oxbow lakes
Lowland rivers
Swamp forest
Mangrove forest
Estuaries
Mud flats
Shallow inshore waters
Corals
Source: http://www.encyclopedia.com.my

Manmade lakes at Kenyir

Orang asli hut along Sungai Bebar peat swamp forest

Oxbow lakes at Kinabatangan River

WETLANDS IN MALAYSIA

Source:google.com

Mangrove forest at Kuala Selangor Nature Park

Mudflats at Gurney Drive Penang

WETLANDS IN MALAYSIA

Merambong seagrass, Pulai River Estuary

WETLANDS IN MALAYSIA

- Malaysia has an extensive area of wetlands.
- The lowlands of Malaysia constitute vast areas of alluvial and coastal plains that slope very gently down to the coasts.
- They spread across 3.3 million hectares, or 10% of Malaysia's total land area, and are diverse in character.
- Lowland flood plains and coastal plains are rich in natural resources, with important habitats like:
  - Mangroves
  - Peatswamp forests
  - Intertidal mud flats

Snakehead fishing Paya Indah Wetlands Malaysia

NATURAL FUNCTION OF WETLAND

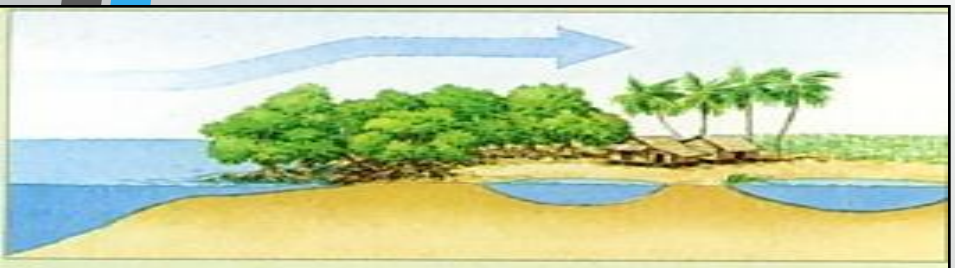
- Biodiversity functions
  - ecosystem diversity
  - link between terrestrial and aquatic ecosystem
  - high species and population diversity
  - highly diverse microbiological activity
- Habitat functions
  - wildlife habitat

NATURAL FUNCTION OF WETLAND

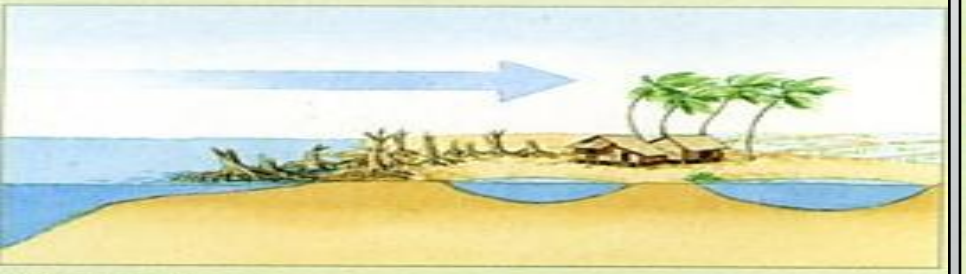
- Climatic effects
  - carbon fixation and CO_2 balance (photosynthesis)
  - rainfall & humidity effects
- Water quality functions
  - particulate filtration
  - nutrient stripping
  - biodegradation of toxic compounds
  - heavy metal removal
  - wastewater treatment and water quality improvement

NATURAL FUNCTION OF WETLAND

- Hydrological & hydraulic functions
  - storm protection
  - coastal erosion protection
  - water holding capacity (water catchment)



Mangroves provide shelter from the wind.

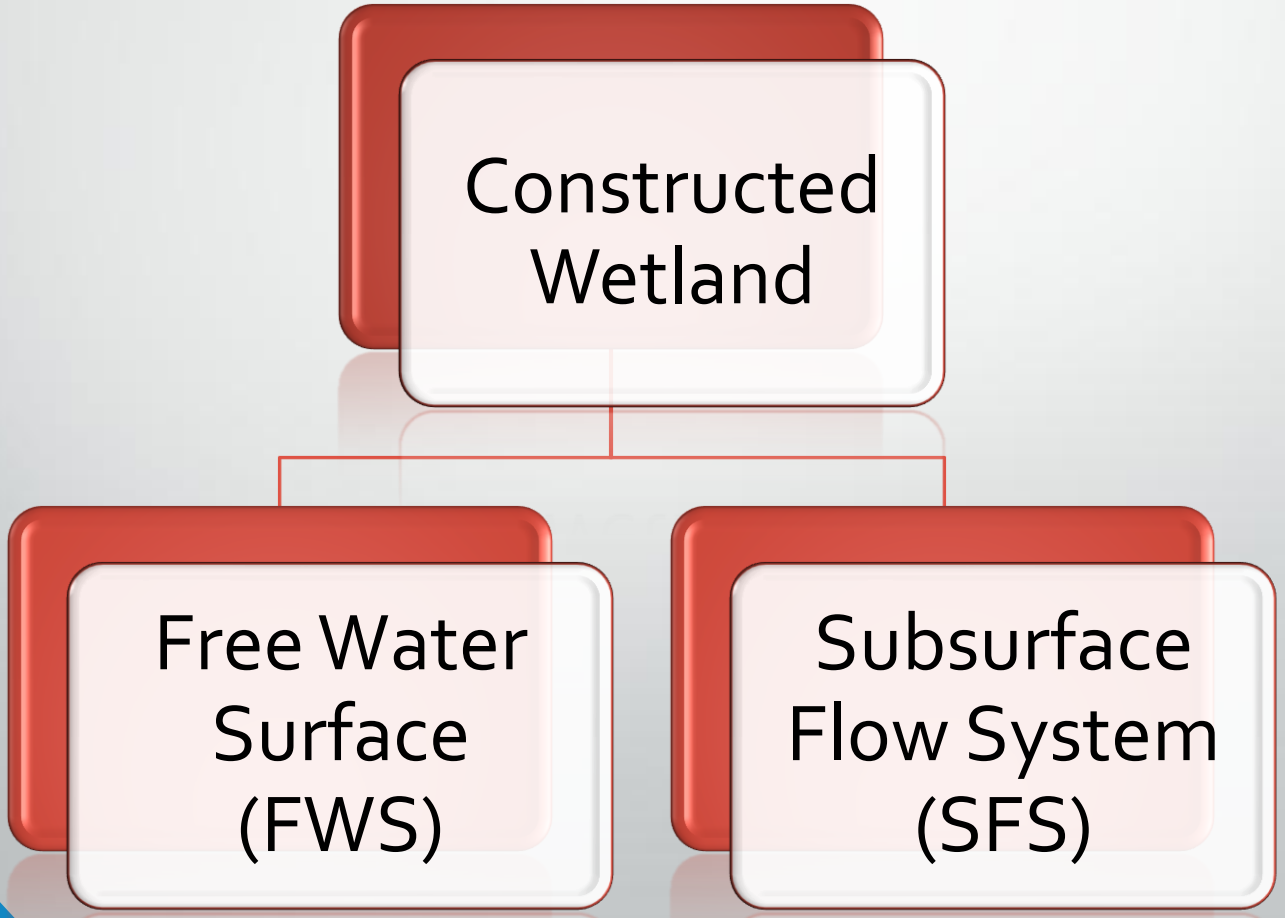


Cutting down mangroves means exposure to storms.

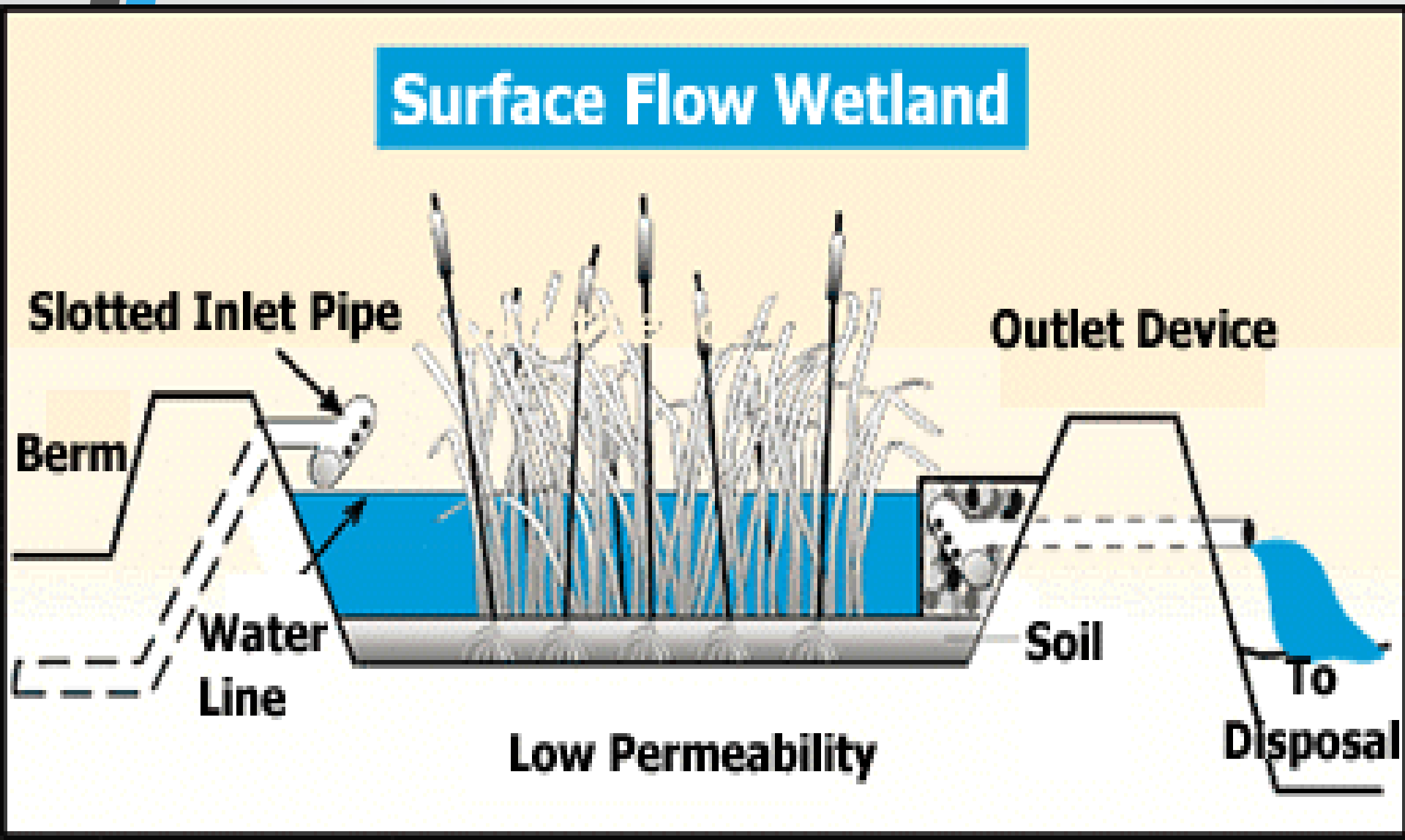
Mangroves protect the shoreline.

Felled mangroves can lead to flooding and coastal erosion.

CONSTRUCTED WETLANDS



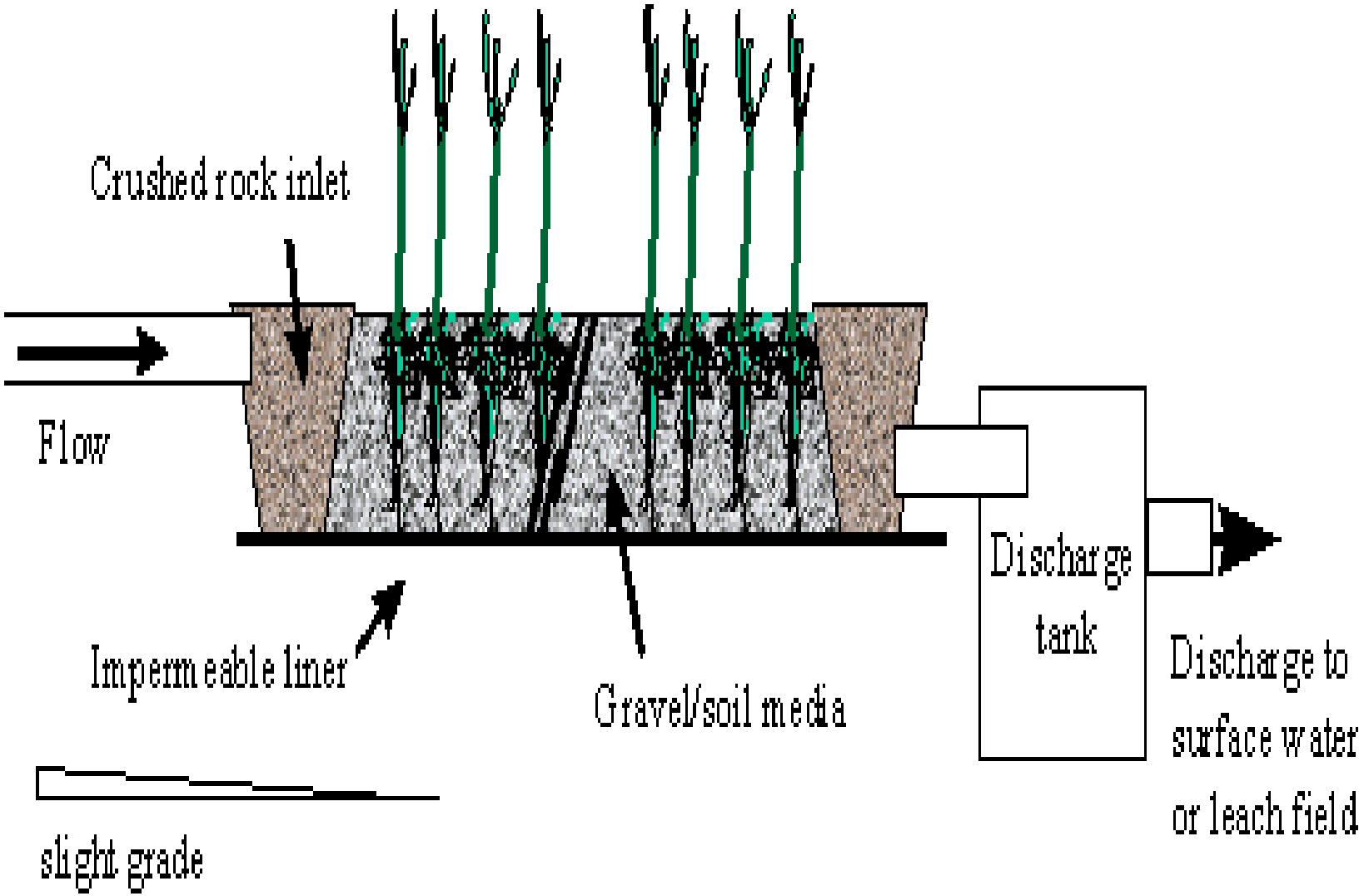
FREE WATER SURFACE (FWS)



FREE WATER SURFACE (FWS)

- Surface flow wetlands are divided into several compartments parallel at low permeability nature of soils
- The sections allow for different amount of oxygen to be present in the water, which then works to optimize various processes for water cleanup
- Inlet pumping water in horizontal flow into wetland treatment area and discharging into receiving water
- There are a large variety of physical and biological processes that contribute to the removal of nutrients, pathogens, and metals from wetlands

SUBSURFACE FLOW SYSTEM (SFS)



SUBSURFACE FLOW SYSTEM (SFS)

- Subsurface-flow wetlands can be further classified as horizontal flow and vertical flow constructed wetlands.
- Subsurface-flow wetlands move effluent through a gravel (generally limestone or volcanic rock lay stone or sand medium) on which plants are rooted.
- Inlet distribution move either horizontally parallel to the surface, or vertically, from the planted layer down through the substrate and out.

TREATMENT PROCESS IN WETLAND SYSTEM

Biodegradable organic matter removal

- Providing support medium for microbial degradation
- Conveying oxygen for aerobic degradation to occur

Solids removal

- Settleable solids are removed easily via gravity sedimentation as wetland systems generally have long hydraulic retention time.
- Filtering of solids by plant stems

TREATMENT PROCESS IN WETLAND SYSTEM (CONT')

Nitrogen removal	Phosphorus removal	Heavy metal removal
• Nitrification / denitrification • Uptake by plants	• Uptake by plants • Microbial degradation • Adsorption and precipitation onto soil	• Uptake into roots, rhizomes and leaves of wetland vegetation.

CRITICAL THINKING SESSION

G1: List the main pollutant that presence in the non point source pollution. Provide the significant impact when each of the pollutant enters the water body.

(8 Marks)

G2: Define 'oxygen demanding waste' and describe two (2) of its impact on water quality. Give two (2) examples.

(6 Marks)

G3: Discuss by giving examples on how the presence of high manganese content in a reservoir could reduce the quality of drinking water distributed to the consumer.

(8 Marks)

G4: State and describe the three (2) functions of vegetation plants in treating wastewater using a wetland system .

(9 Marks)

CRITICAL THINKING SESSION

G5: Using the idea of biological magnification, illustrate why would larger tuna contain more mercury than smaller tuna.

(5 Marks)

G6: Describe the importance of wetland in terms of hydrological function. Give two (2) examples with brief description.

(9 Marks)

G7: Give reasons why the activities of power plants could cause adverse impact on water quality. Suggest proper ways to overcome the problem.

(5 Marks)

G8: Provide 3 effective BPs to reduce non-point water pollution source-related. Give full description for each of the suggested methods on how it may help to protect the water body.

(9 Marks)

RULES AND REGULATIONS

- Why need?
- History
- Standard in Malaysia
- Environmental Quality Act 1974
- Incentives complying with legislation

WHAT IS ENVIRONMENTAL LEGISLATION? - LAWS, REGULATIONS & TIMELINE

ENVIRONMENTAL LEGISLATION FOR POLLUTION PREVENTION

- Environmental legislation as key tool for minimizing or preventing pollution
- Understanding key environmental legislation for sound industrial practices

Planning to be a good corporate citizen

YEAR	RESOURCE	LEGISLATION
1920	Water	Water Enactments
1929	Mining	Mining Enactment
1930	Nature	State Parks Act
1935	Forestry	Forest Rules
1936	Fisheries	Fisheries Act
1952	Road Transport	Road Enactments & Ordinance
1952	Merchant Shipping	Merchant Shipping Ordinance
1960	Soil	Pesticides Act
1967	Industry	Factories & Machinery Act
1974	Housing	Local Government Act (street, drainage and building act)
1974	Environment	Environment Quality Act (EQA)
1980	Land	Land Conservation Act
1984	Radioactivity	Atomic Energy Licensing Act

ENVIRONMENTAL REGULATION IN MALAYSIA: HISTORY

- In Malaysia environment acts and regulations were established in 1970s.

- Environmental Quality Act 1974 is an act related to the prevention, abatement, control of pollution and enhancement of the environment.

WATER QUALITY STANDARDS IN MALAYSIA

- Water Quality Standards for Surface Water
- Water Quality Standards for Marine Water
- Water Quality Standards for Groundwater

WATER QUALITY STANDARDS FOR SURFACE WATER

INTERIM NATIONAL WATER QUALITY STANDARDS

- is applied **to surface waters** which contain standard values of **72 parameters** in **6 water use classes**.
- the main purpose of the standard is to improve water quality gradually in order to meet the standards of the better water class
- Classification of rivers or river segments are classified in 6 classes **(I, IIA, IIB, III, IV and V)** - Class I being the best and Class V being the worst.

CLASS	USES
CLASS I	Conservation of natural environment water supply 1 - practically no treatment necessary. Fishery 1 - very sensitive aquatic species
CLASS IIA	Water Supply II - conventional treatment required Fishery ll - sensitive aquatic species
CLASS IIB	Recreational use with body contact
CLASS III	Water Supply lll - extensive treatment required Fishery lll - common, of economic value, and tolerant species livestock drinking
CLASS IV	Irrigation
CLASS V	None of the above

WATER QUALITY STANDARDS FOR SURFACE WATER

- In order to simplify the extensive amount of data collected, an indexing system - **Water Quality Index (WQI)** was introduced.

- The purpose of WQI is to summarize large amounts of water quality data for a specific river into simple terms and makes it easily understandable for communities in the river basin and for river basin management.

DOE Water Quality Index Classification

PARAMETER	UNIT	CLASS				
		I	II	III	IV	V
Ammonical Nitrogen	mg/l	< 0.1	0.1 - 0.3	0.3 - 0.9	0.9 - 2.7	> 2.7
Biochemical Oxygen Demand (BOD_5)	mg/l	< 1	1 - 3	3 - 6	6 - 12	> 12
Chemical Oxygen Demand (COD)	mg/l	< 10	10 - 25	25 - 50	50 - 100	> 100
Dissolved Oxygen (DO)	mg/l	> 7	5 - 7	3 - 5	1 - 3	< 1
pH	-	> 7	6 - 7	5 - 6	< 5	> 5
Total Suspended Solid	mg/l	< 25	25 - 50	50 - 150	150 - 300	> 300
Water Quality Index (WQI)	-	< 92.7	76.5 - 92.7	51.9 - 76.5	31.0 - 51.9	> 31.0

Parameters	What it indicates
Ammoniacal Nitrogen (AN)	Indicates nutrient status, organic enrichment and health of the water body
Biochemical Oxygen Demand (BOD)	Procedure for determining how fast biological organism use of oxygen in a body water
Chemical Oxygen Demand (COD)	Indicates the amount of organic pollutants in water
Dissolved Oxygen (DO)	Measures the amount of oxygen dissolved or carried in the water
pH	Indicates contamination and acidification
Suspended Solid (SS)	Small solid particles which remain in suspension in water as a colloid or due to the motion of water

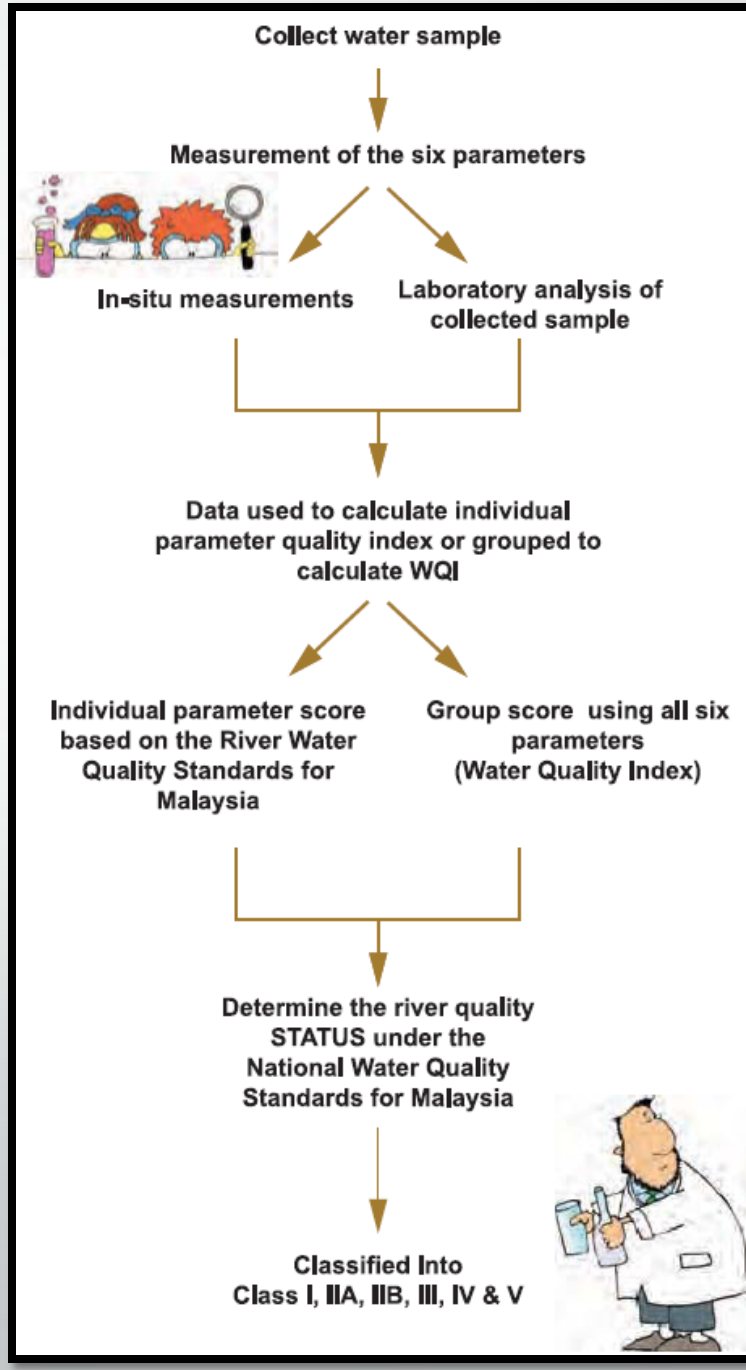
WATER QUALITY INDEX (WQI)

$$WQI = 0.22 \times SI\ DO + 0.19 \times SI\ BOD + 0.16 \times SI\ COD + 0.15 \times SI\ AN + 0.16 \times SI\ SS + 0.12 \times SI\ pH$$

SI DO : Sub-Index DO (% saturation)
SI BOD : Sub-Index BOD
SI COD : Sub-Index COD
SI AN : Sub-Index NH3-N
SI SS : Sub-Index SS
SI pH : Sub-Index pH

Pollution status based river classification

SUB INDEX & WATER QUALITY INDEX	INDEX RANGE		
	CLEAN	SLIGHTLY POLLUTED	POLLUTED
Biochemical Oxygen Demand(BOD)	91 - 100	80 - 90	0 - 79
Ammoniacal Nitrogen (NH_3-N)	92 - 100	71 - 91	0 - 70
Suspended Solids(SS)	76 - 100	70 - 75	0 - 69
Water Quality Index(WQI)	81 - 100	60 - 80	0 - 59



WATER QUALITY STANDARDS FOR MARINE WATER

- Marine water quality plays an important part in the conservation of marine resources, which contribute to the stability of the marine ecosystem
- Pollution from land-based sources as well as from the sea can pose threats to these invaluable resources
- In Malaysia, DOE started the monitoring program in 1978 for Peninsular Malaysia and in 1985 for Sabah and Sarawak. The program included in-situ measurements and laboratory analyses.

in-situ measurements	Unit	Laboratory analysis	Unit
Temperature (Temp)	deg C	*Escherichia coli* (*E.coli*)	MPN/100ml
pH	unit	Oil & Grease (O&G)	mg/l
Dissolved Oxygen (DO)	% Sat	Total Suspended Solids (TSS)	mg/l
Dissolved Oxygen (DO)	mg/l	Arsenic (As)	mg/l
Conductivity (Cond)	mS/cm	Cadmium (Cd)	mg/l
Salinity (Sal)	ppt	Chromium (Cr) Total	mg/l
Turbidity (Tur)	NTU	Cuprum (Cu)	mg/l
Tarball	g/100m	Plumbum (Pb)	mg/l
		Mercury (Hg)	mg/l

Aquatic life – ocean goose die due to the consumption of tarballs

Parameter (lab)	Unit	Interim standards
Escherichia coli (*E.coli*)	MPN/100ml	100
Oil & Grease (O&G)	mg/l	0
Total Suspended Solids (TSS)	mg/l	50
Arsenic (As)	mg/l	0.1
Cadmium (Cd)	mg/l	0.1
Chromium (Cr) Total	mg/l	0.5
Cuprum (Cu)	mg/l	0.1
Plumbum (Pb)	mg/l	0.1
Mercury (Hg)	mg/l	0.001

WATER QUALITY STANDARDS FOR GROUNDWATER

- Ground Water Quality Standards for Malaysia is still not established, but considering potential of groundwater as an alternative source for surface water.
- DOE had started the National Groundwater Monitoring Program to determine the groundwater quality status.
- Since the standards is still not established, the groundwater quality status was determined based on the National Guidelines for Raw Water Quality as the benchmark.

Parameter	Symbol	Benchmark
Sulphate	SO_4	250 mg/l
Hardness	$CaCO_3SO$	500 mg/l
Nitrate	NO_3SO	10 mg/l
Coliform	-	Must not be detected in any 100 ml sample
Manganese	Mn	0.1 mg/l
Chromium	Cr	0.05 mg/l
Zinc	Zn	3 mg/l
Arsenic	As	0.01 mg/l
Selenium	Se	0.01 mg/l
Chloride	Cl	250 mg/l
Phenolics	-	0.002 mg/l
Total Dissolve Solid	-	1000 mg/l
Iron	Fe	0.3 mg/l
Copper	Cu	1.0 mg/l
Lead	Pb	0.01 mg/l
Cadmium	Cd	0.003 mg/l
Mercury	Hg	0.001 mg

Environmental Quality Act 1974 (Act 127)

- Environmental Quality Act 1974 is a sign of commitment of Malaysian towards nature.
- This Act is related to the prevention, abatement, control of pollution and enhancement of the environment.
- It also deals with the administration of the environment and towards the achievement of the national environmental policy.

Environmental Quality Act 1974 (Act 127)

- Regulations and orders enforced under Act 127:
  - Peraturan-peraturan Kualiti Alam Sekeliling (Premis yang ditetapkan) (Minyak Kelapa Sawit Mentah) 1977
  - Peraturan-peraturan Kualiti Alam Sekeliling (Premis yang ditetapkan) (Getah Asli Mentah) 1978
  - Peraturan-peraturan Kualiti Alam Sekeliling (Kumbahan dan Effluen-Effluen Perindustrian) 1979

- Piawai-piawai Kualiti Air (Garis Panduan/ Guidelines)
  - Water Quality Index (DOE-WQI)
  - Interim National Water Quality Index (INWQS)

INCENTIVES FOR COMPLYING WITH LEGISLATION

- Good business sense
- Adopt pollution prevention strategy for complying with legislation
- Aware deteriorating state of environment (oil spill, river pollution)
- Alert human lives endangered level (landslide fatalities)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