“Zero Liquid Discharge” Concept for Efficient Management of Urban Waters & Wastewaters

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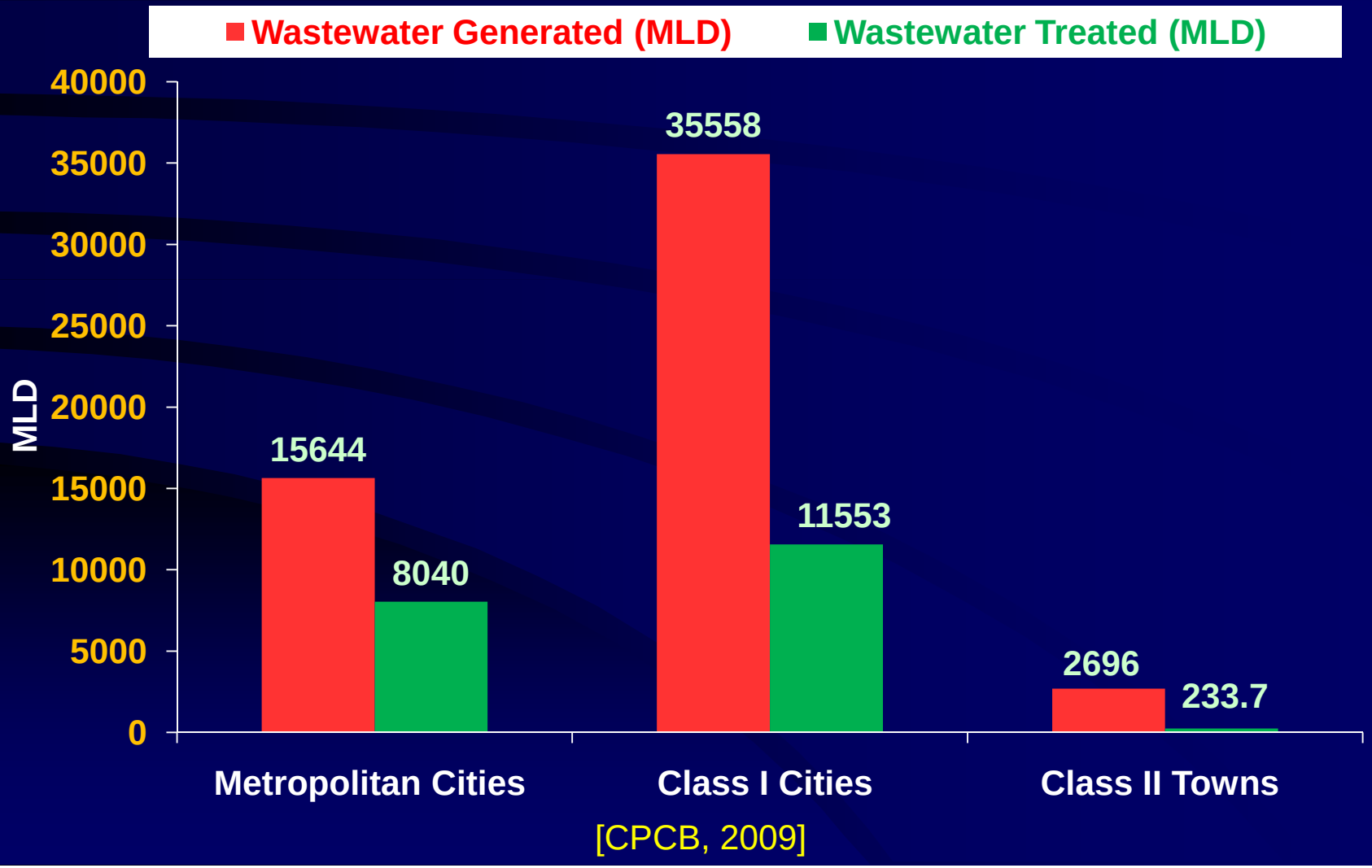
Water Scenario in Developing Countries

- Inadequate water supply and poor water quality
- Increasing demand for water for domestic, agriculture, as well as industrial purposes
- Available water resources continuously getting deteriorated

Causes

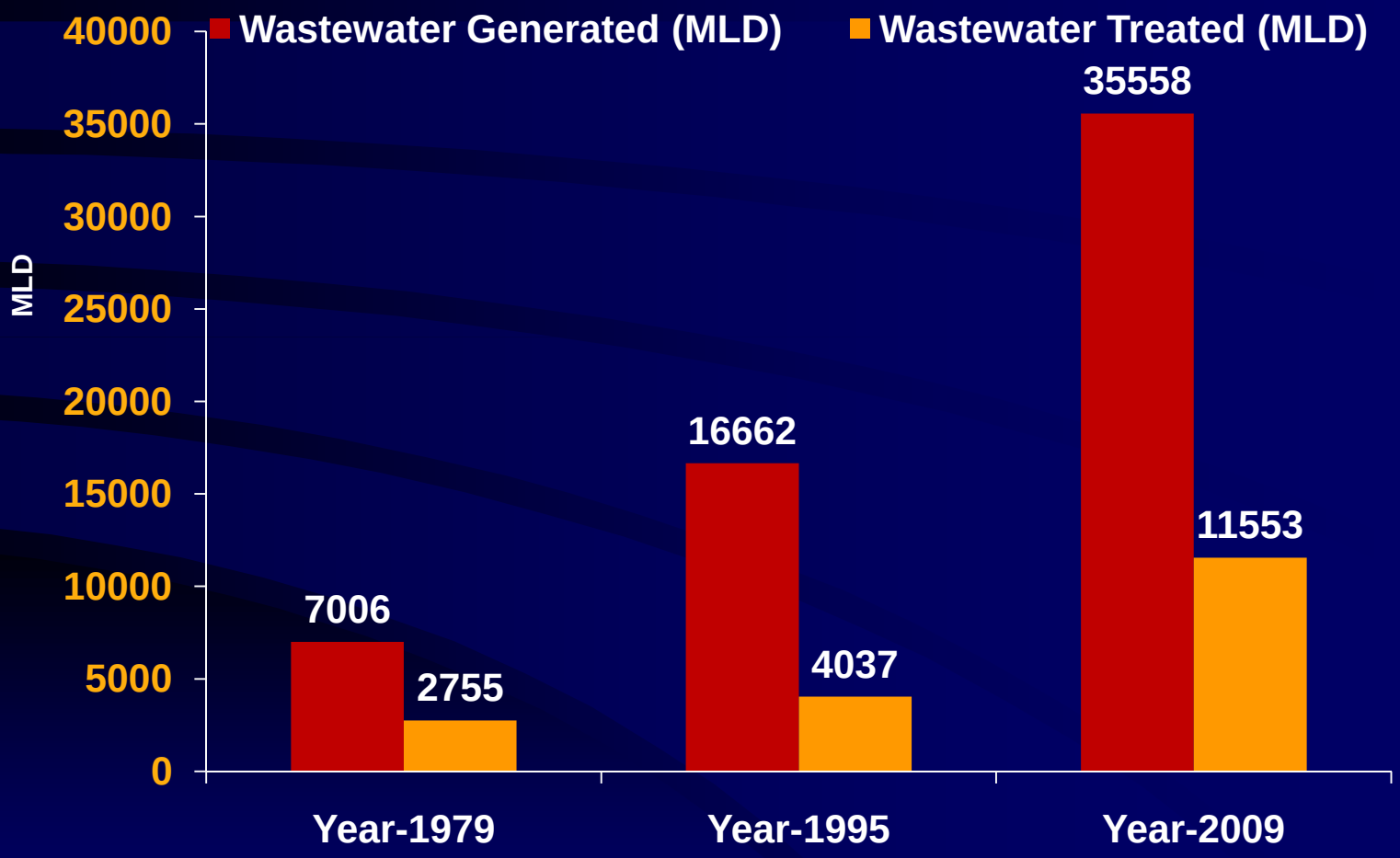
- Discharge of partially treated or untreated wastewater/ effluents into water reservoirs
- Agricultural and Urban runoff
- Increasing water demand
- Excessive water withdrawal prevents dilution of pollutants

Wastewater Treatment in India



[CPCB, 2009]

Trends of Wastewater Treatment and Management in India



(Source: CPCB, 2009)

The Imminent Challenges in Management of Water Resources

- Pollution due to disposal of untreated (or partially treated) sewage and sullage into natural watercourses and

- Pollution caused by disposal of industrial wastewater into sewers and watercourses

One usually encountered solution is to treat the sewages and wastewaters to regulatory standards and then dispose them off into receiving bodies!

The other less favored solution is to treat the sewages and wastewaters to much HIGH standards and then reuse / recycle them!

Reclamation of Wastewaters for Recycling and Reusing: *A New Horizon*

- **The treated effluent is used as a water resource for beneficial purposes**

  ------*New* and *assured* water source

- **The effluent is kept out of streams, lakes, and beaches;**

  ------ *Reduces* pollution of natural water reservoirs

Reclamation… *cont'd…*

Reuse:

To extend the life of resource/product by using it again, repairing it, modifying it or creating new uses for it

Recycle:

Collecting and reprocessing already manufactured materials for remanufacture either as the same thing or as part of a different product

Reduce:

To bring down use of resource/material to a smaller extent, size, amount or quantity

Solution – Water Recycling

Advantages:

- **Achieving 24 x 7 water supply**
  - ➢ **Reduced consumption of potable water**
  - ➢ **Elimination of pollution of watercourses**

- **Reducing the cost of wastewater treatment**

Points for Immediate Action

- The installation and operating costs of existing technologies are rather high and hence are ill-afforded by the communities
- The available technologies are often complex, require heavy machinery that are capital intensive as well as energy intensive during operation and
- The technologies usually rely upon expensive chemical inputs (such as chlorine, alum, lime, poly-electrolyte, etc.) and generate sludges that may be hazardous in nature and difficult to de-water and dispose

What is “Appropriate”?

- Low cost with Minimum possible Mechanization
- Simple in Operation
- Suitable for Incremental improvement and
- Recycle and Reuse oriented

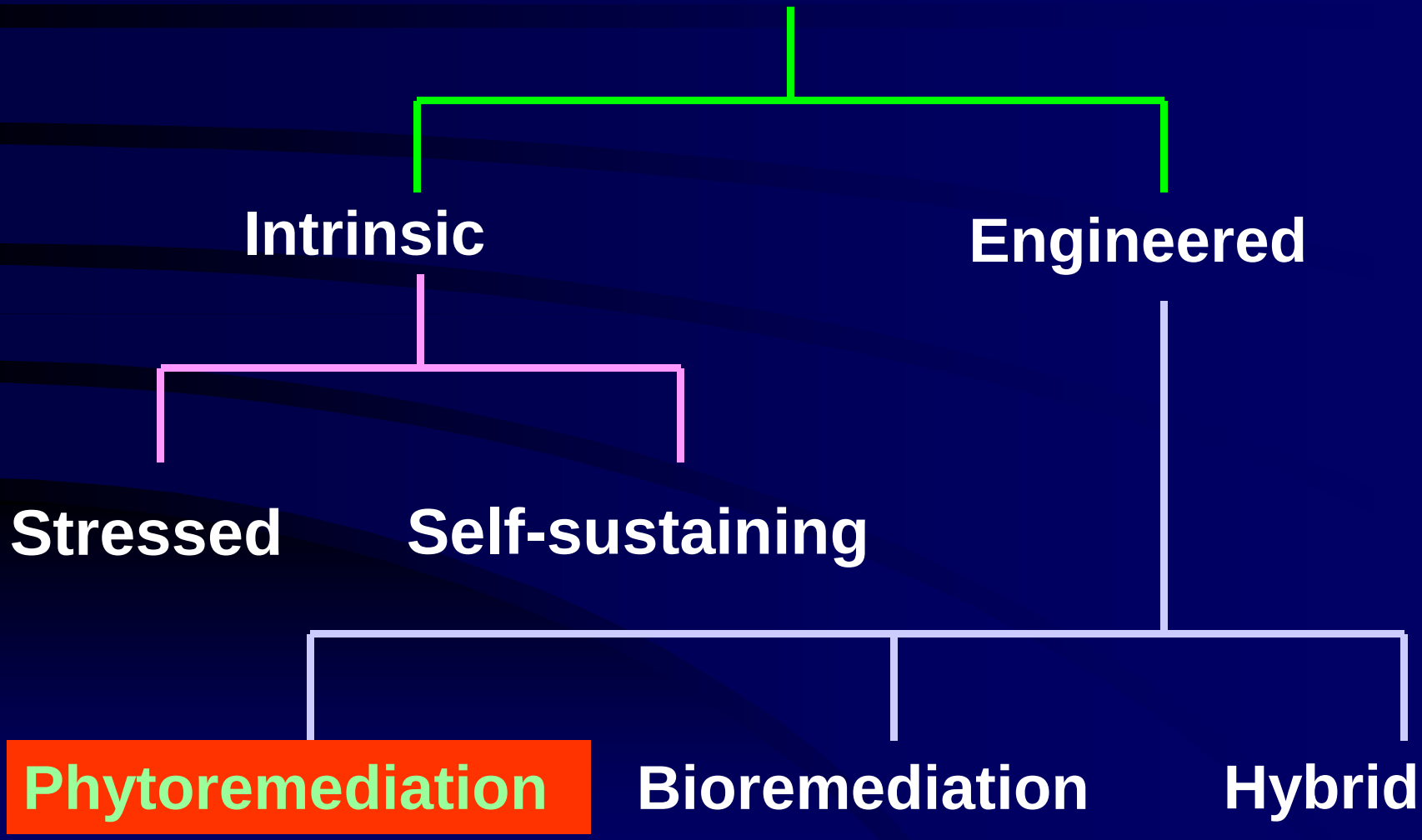
Decentralized Solutions are Appropriate

- **Effective and low-cost**
- **NTSs Utilize plants and their associated rhizospheric microorganisms**
- **Natural synergistic relationship**
  - ***plants***
  - ***soil***
  - ***microorganisms and***
  - ***water***

Community Is the Key!

- Natural treatment systems require local dedication, support and cooperation
- Eventually, the community will assume project ownership and
- Ultimately, benefits must be enough for the community to want to keep the project intact

Classification of Natural Treatment Systems



(Source: Chaturvedi *et al.*, 2008)

Aquatic Natural Treatment Systems

The most common NTSs include

- **Waste Stabilization Ponds (WSPs)**
- **Hyacinth and Duckweed Ponds (DPs)**
- **Fish Ponds**
- **Oxidation Ponds and Lagoons**
- **Algal-bacterial ponds**
- **Polishing Ponds (PPs) and**
- **Constructed Wetlands (CWs) *etc***

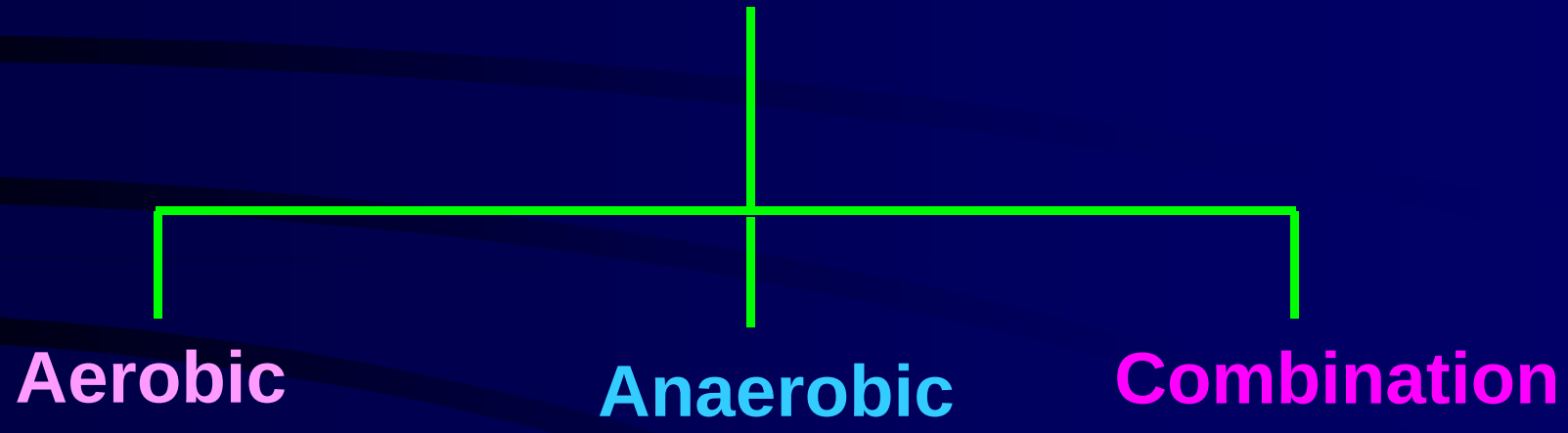
Physico - Chemical (Primary)

- Oil and Grease Removal
- Screen and Grit Removal
- Coagulation and Flocculation
- Sedimentation
- Plate Settlers and Tube Settlers
- pH Adjustment
- Sludge Thickeners
- Vacuum Filters
- Centrifuges

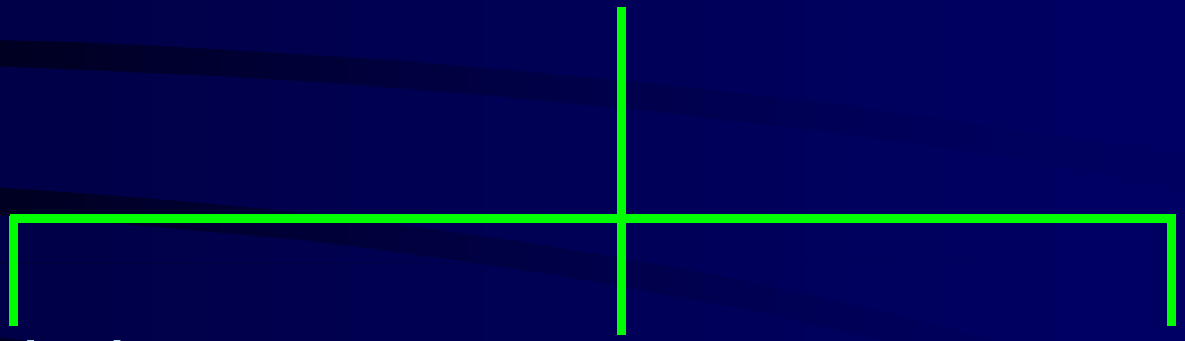
Physico - Chemical (Advanced)

- Ion-exchanging
- Membrane Separation (RO)
- Membrane Filtration (UF, MF, NF)
- Sorption (PAC, GAC)
- Solvent Extraction
- Molecular Sieves

Classification of Biological Systems



Classification of Aerobic Biological Systems



Suspended Growth

Activated Sludge Process
Membrane Bioreactor
Aerobic Lagoons

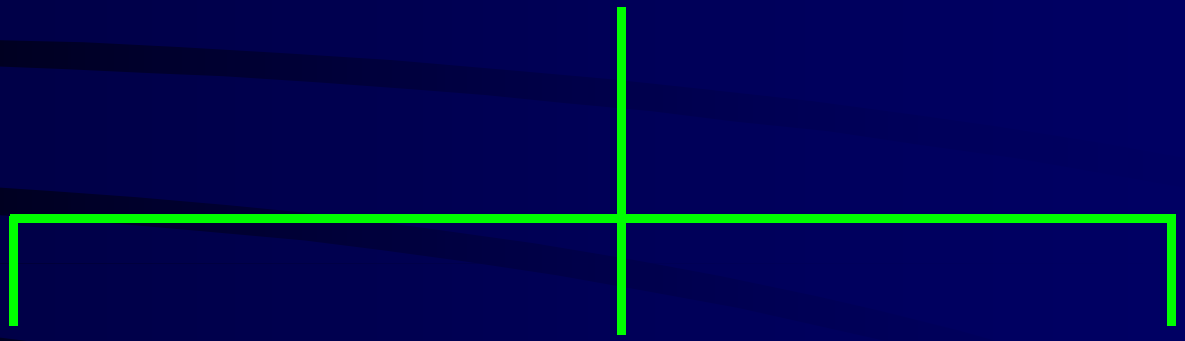
Attached Growth

Trickling Filters
Rotating Biological Contactors

Combination

Fluidized Bed Biofilm Reactor (FBBR)

Classification of Anaerobic Biological Systems



Suspended Growth

UASBs
Anaerobic Filters

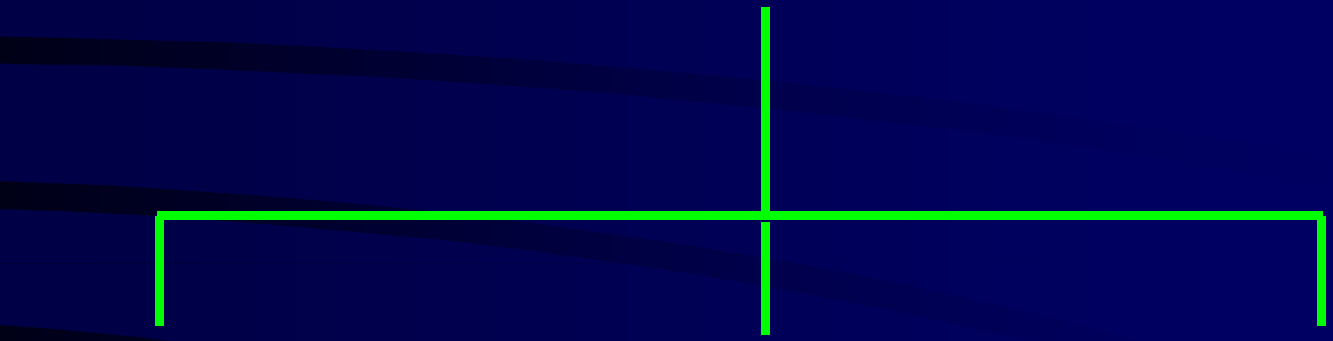
Attached Growth

Anaerobic Sludge Digester
Anaerobic Contact Reactors
Bio-gas Reactors (Gobar gas)

Combination

Expanded Bed Reactor

Classification of Biological Systems



Aerobic

Anaerobic

Combination

- Facultatvie Lagoon
- Sequential Bio-Reactor
- SSND Process

Zero Discharge?
Near-Zero Discharge?

- **Zero discharge** differs from **pollution prevention** from the perspective of converting all the wastes to useful materials

- **Zero Discharge** is the **final destination** of the journey towards preventing pollution

- In reality, **absolute zero discharge** condition may not be always possible to achieve - but, **near zero discharge** can be achieved!

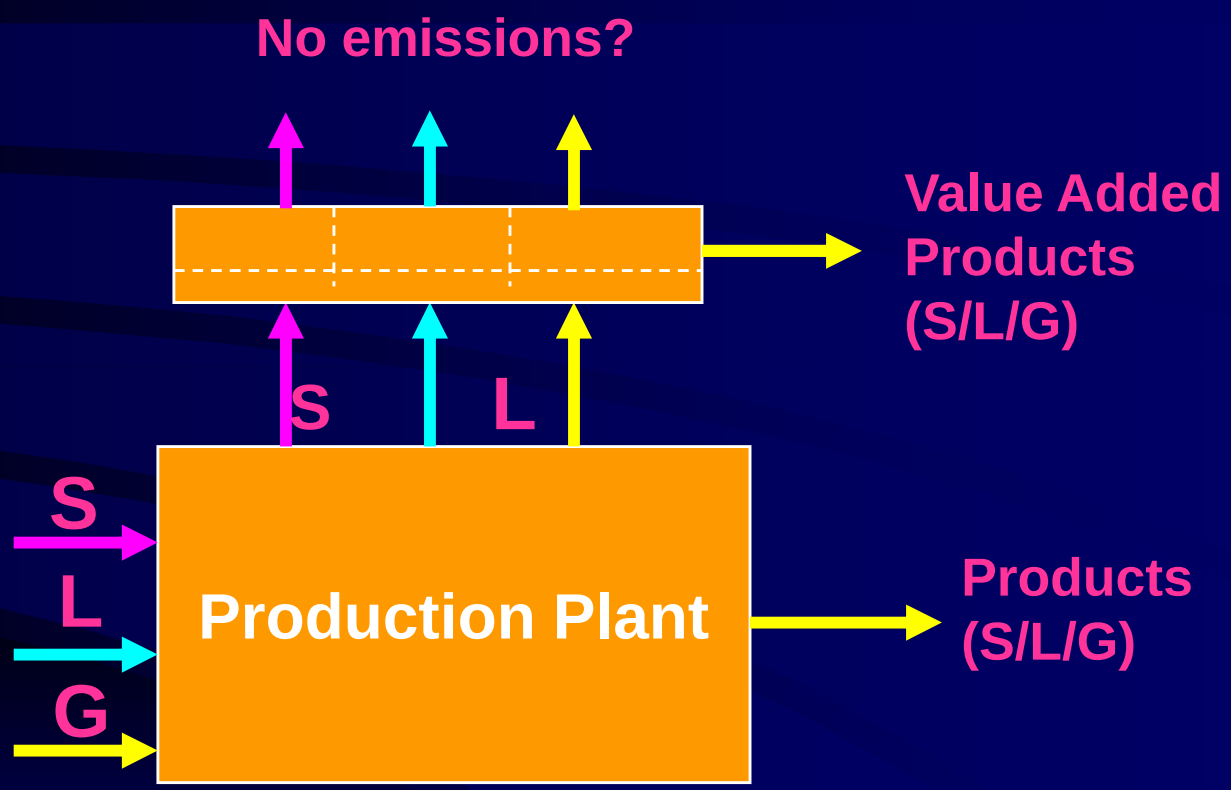
Zero Discharge… *cont'd…*

- **In its broadest sense, "zero discharge" means no discharge or emissions to any media** (say, river, lake, reservoir, creek or estuary)

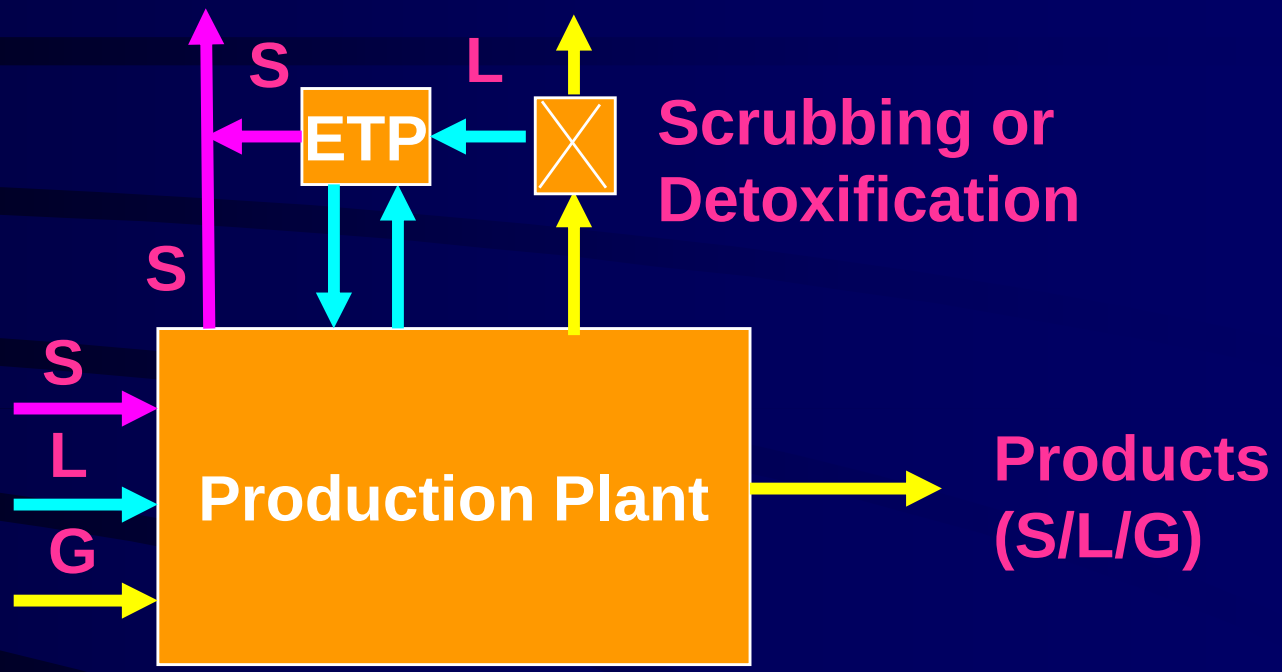
- **More commonly, "zero discharge" focuses on the Zero Liquid Discharge (ZLD)**

- **The time has come for insisting the inclusion of other kinds of wastes including gases, sludges vapors and even irrigation of treated wastewaters under "zero discharge" discussion!**

Theoretical Zero Discharge



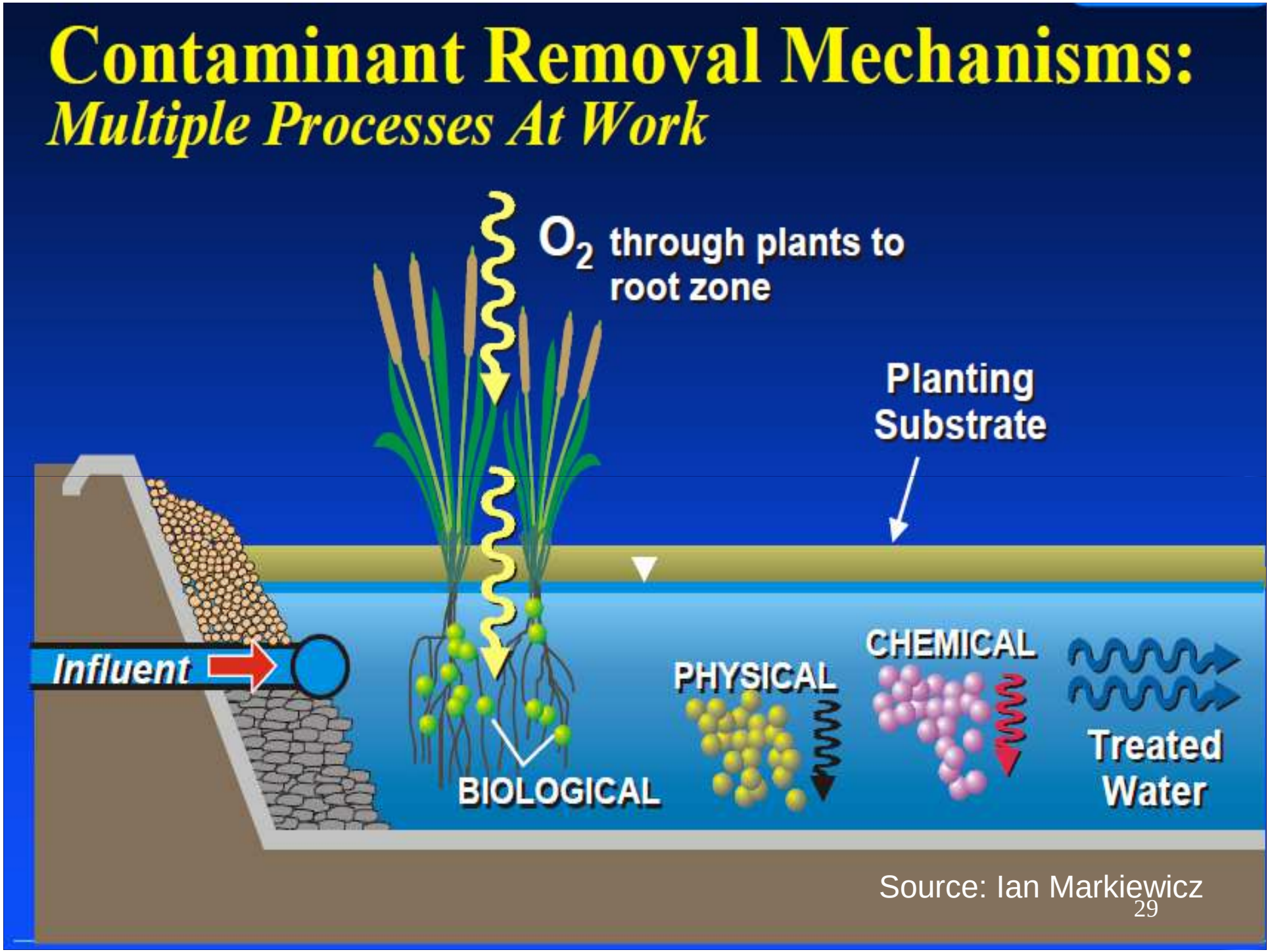
Zero Liquid Discharge



Technological Options for Zero Liquid Discharge (ZLD)

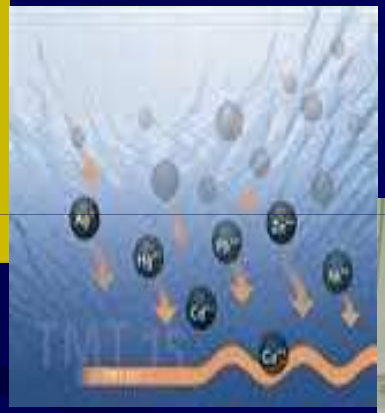
- Reverse Osmosis
- Thermal/Vacuum Evaporation
- Electrodialysis
- Ion Exchange

Constructed Wetland Research in IIT Bombay


Contaminant Removal Mechanisms:
Multiple Processes At Work
O_2 through plants to root zone
Planting Substrate
Influent
BIOLOGICAL
PHYSICAL
CHEMICAL
Treated Water
Source: Ian Markiewicz

Types of Contaminants Removed

N - P - K



Laboratory CW Reactors Installed for Investigation

Collection and Analysis of Biomass from Field

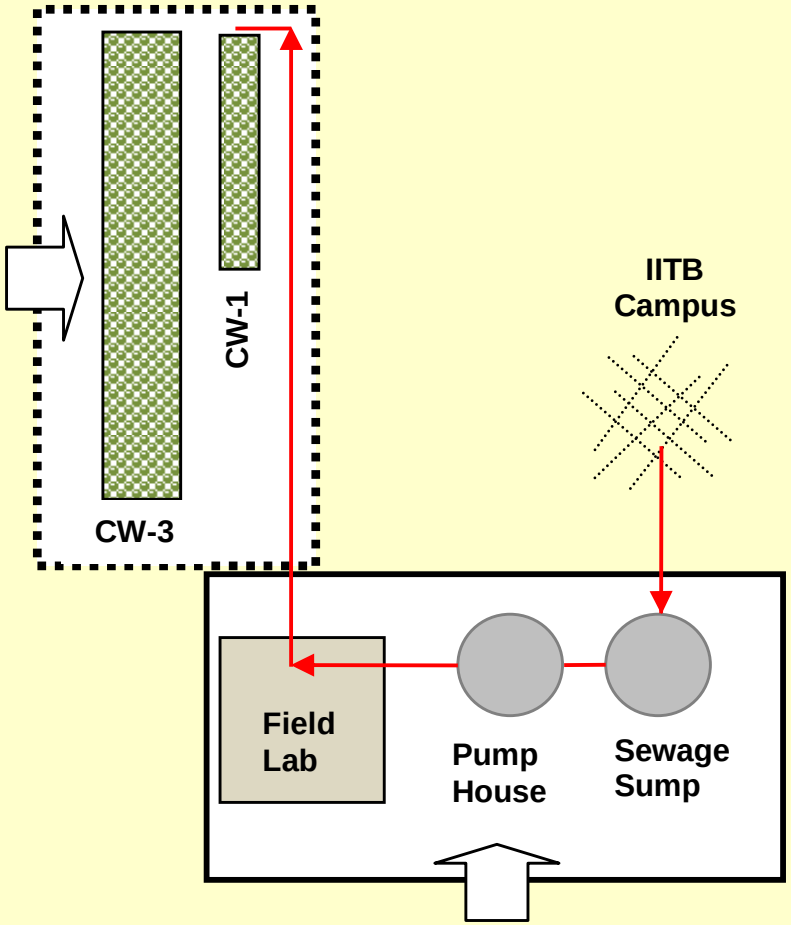
Typha latifolia

Typha latifolia

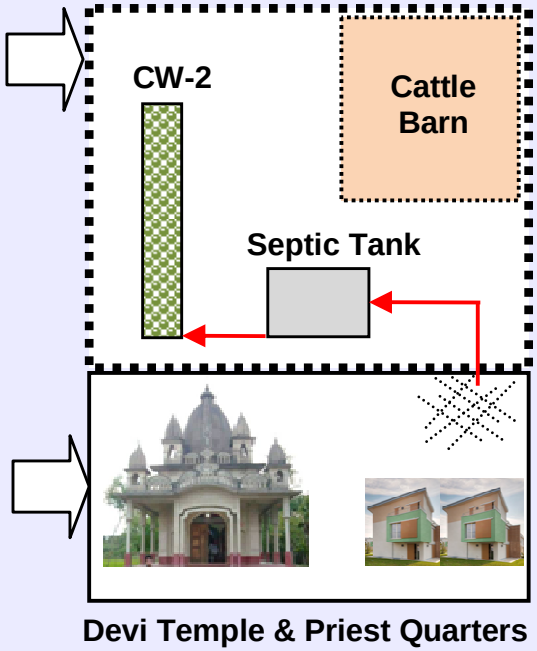
Canna indica

Canna indica

Establishing CW Research Stations on IITB Campus



Research Station: Water Prospects



Research Station: Water Blessing

Success Story of Rejuvenation of Mansagar Lake, Jaipur

Man Sagar Restoration Model...success through *INNOVATION*

Reviving Art - Culture - Environment

Jal Mahal Resorts Pvt Ltd

JAL TARANG
JAL MAHAL VALLEY

Success through Eco-System based Scientific approach…

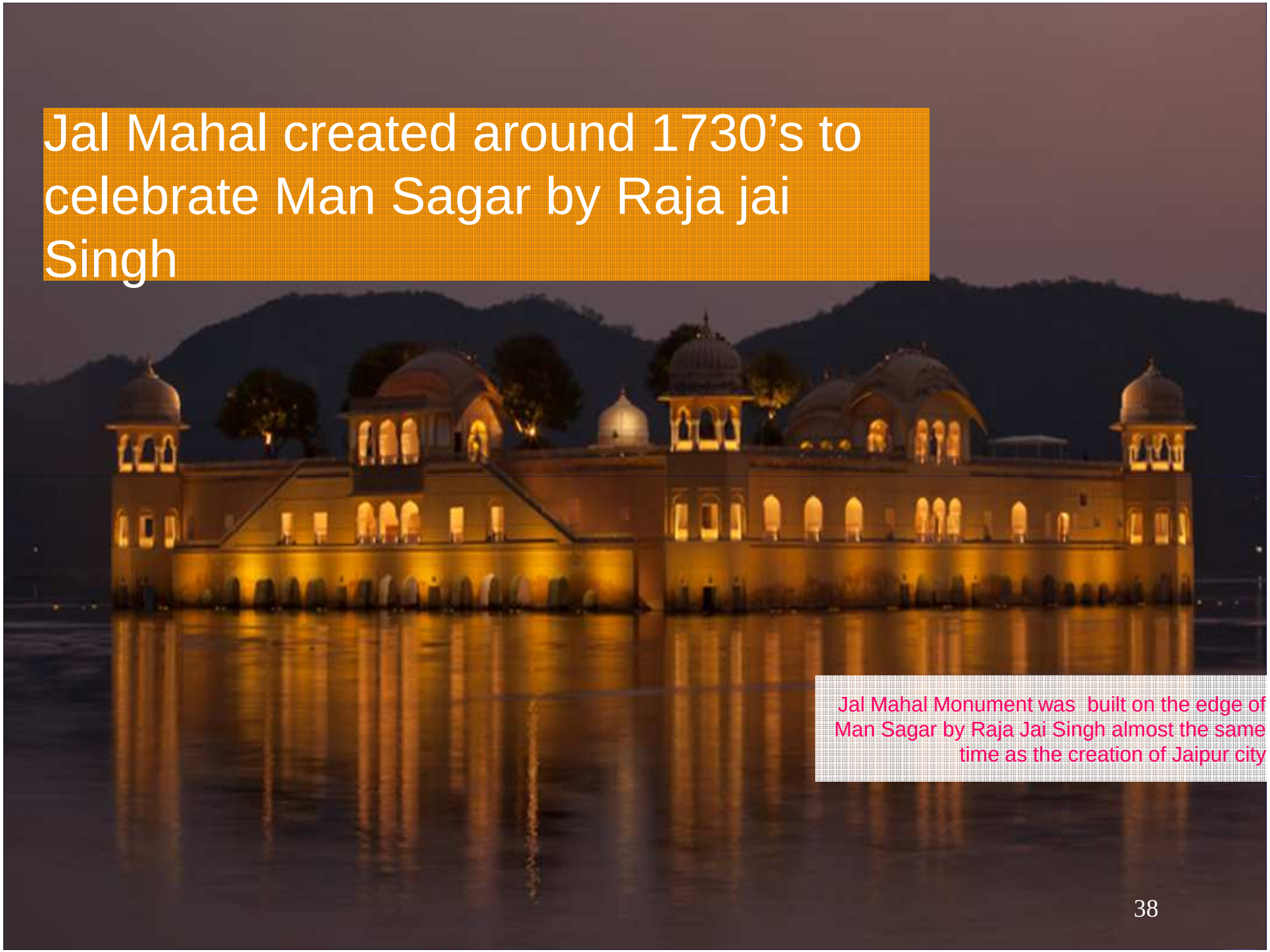
Multidisciplinary team

- Environmental Scientists
- Environmental Engineers
- Hydrologist
- Chemical Engineer
- Botanist
- Environmental Activist
- Landscape Architects
- Local flora and fauna experts
- And more…

…revived Man Sagar Lake habitat has been widely excepted by Nat its creations…

Jal Mahal has been abandoned for more than a century...picture from late 1800’s

Jal Mahal created around 1730's to celebrate Man Sagar by Raja jai Singh

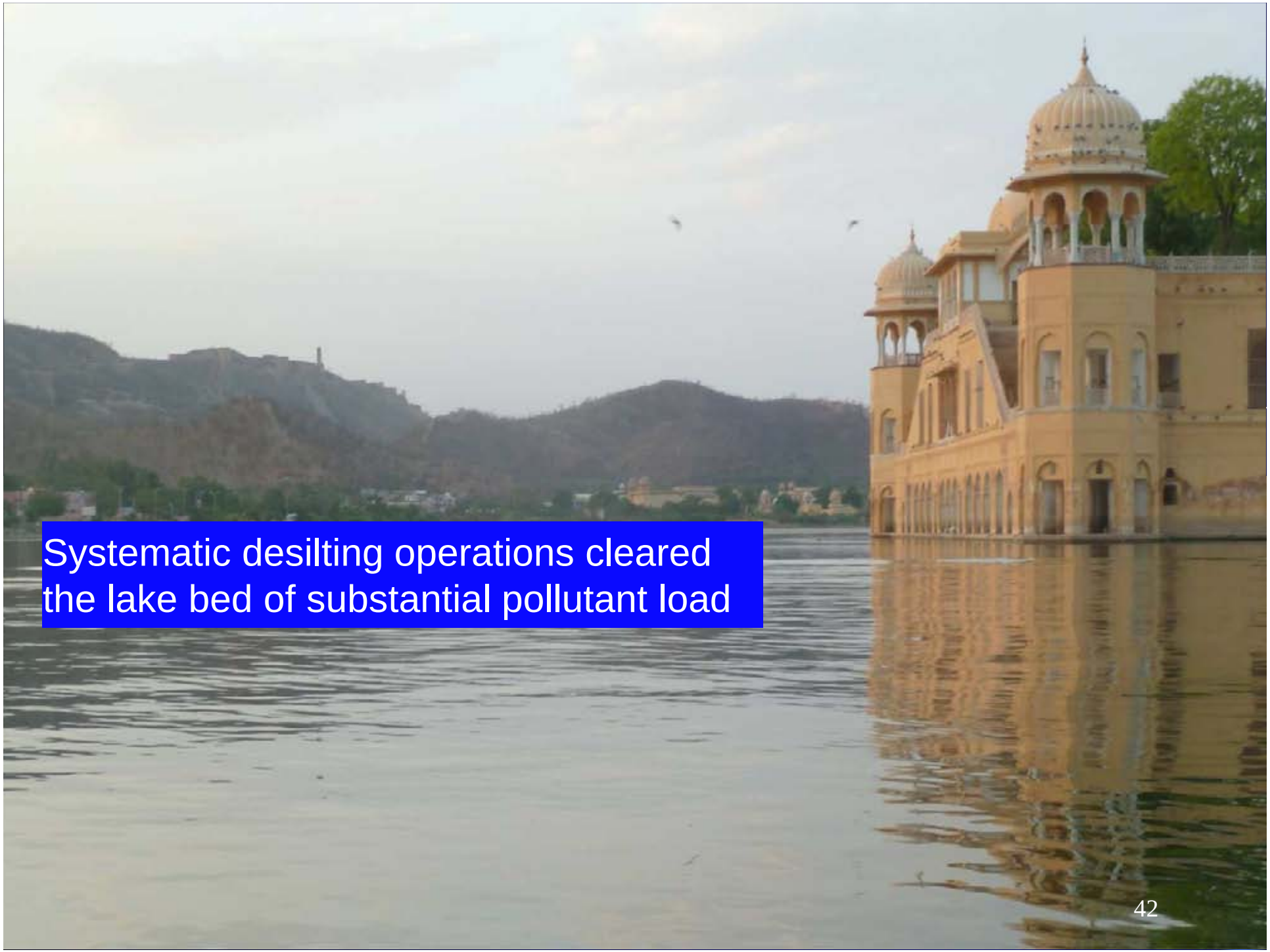


Jal Mahal Monument was built on the edge of Man Sagar by Raja Jai Singh almost the same time as the creation of Jaipur city


Summers of
2003, 2004, 2005...


Summers of
2009, 2010, 2011...


Heavy pollutants load existed on lake bed


Systematic desilting operations cleared
the lake bed of substantial pollutant load

Resident - Breeding birds at Mansagar lake

Ashy prinia in Br. plumage

Black Crowned Night Heron using post

Black Headed Myna

Chestnut Shouldered Petronia

Common Moorhen (R. Br.)

Cormprants using stumps of dead trees

Great Egret Br. Plumage

Greater Coucal

Green Bee Eater

Purple Sunbird male

Spot Billed Duck with Juveniles

WhiteThroated Kingfisher

Migratory Birds at Mansagar lake

Small Pratincole

Ruff

Rosy Starling

Red Shank

Greater Painted Snipe female

Common Starling

Common Sandpiper (Mig.)

Common Sand Piper- migratory

Common Coot (Mig.)

Comb Duck

Temminck's Stint

Tawny Pipit

What Should Be Our Mission?

DIRECTIVE PRINCIPLE [Art. 48-A]

"The state shall endeavor to protect and improve the environment and to safeguard the forests and wildlife."

What Should Be Our Mission? [… . continued]

FUNDAMENTAL DUTY [Art. 51-A(g)]

“The "FUNDAMENTAL DUTY" of every citizen is to protect and improve the natural environment including forests, lakes, rivers, and wildlife and to have ecological compassion.”

Thank you!

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