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Urban wastewater planning and management – experiences from Pakistan
Case Study: Bioremediation Interventions at NUST Islamabad Campus

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National Dialogue on Water Security: Implementing Water Goals in Timor-Leste
16-17 October 2017
Dili, Timor-Leste

Hazards of Untreated Water

- Pollutes flowing water in channels
- Pollutes the underground aquifers
- Foods produced from untreated waste water poses serious health risks

Major Contaminants in Wastewater

Physical

- Suspended Solids
- Dissolved Solids

Biological

- Pathogens (Bacteria, Viruses etc)

Others

- Refractory Organics
- Heavy Metals
- Primary Pollutants

Various Technologies for Treating Wastewater

More than 70 techniques used worldwide

- Activated Sludge systems
- Biofilters (FILTER – **F**ilteration & **I**rrigated Cropping for **L**and **T**reatment & **E**ffluent **R**euse)
- Bioreactors
- Constructed wetlands
- Diffuser
- Electrolysis
- Floatation
- Ion exchange
- Media Filter
- Membrane Bioreactor
- Retention Basin
- Sedimentation Tank

Limitations

- High Initial Capital Cost
- Energy Intensive
- High Maintenance and Operational Costs
- Some Techniques yet not mature enough for field applications

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Conventional Treatment Methods

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Agenda 2030

UN World Conference on
Disaster Risk Reduction
2015 Sendai Japan

UNITED NATIONS
PARIS CLIMATE
AGREEMENT
SIGNING CEREMONY
22 APRIL 2016

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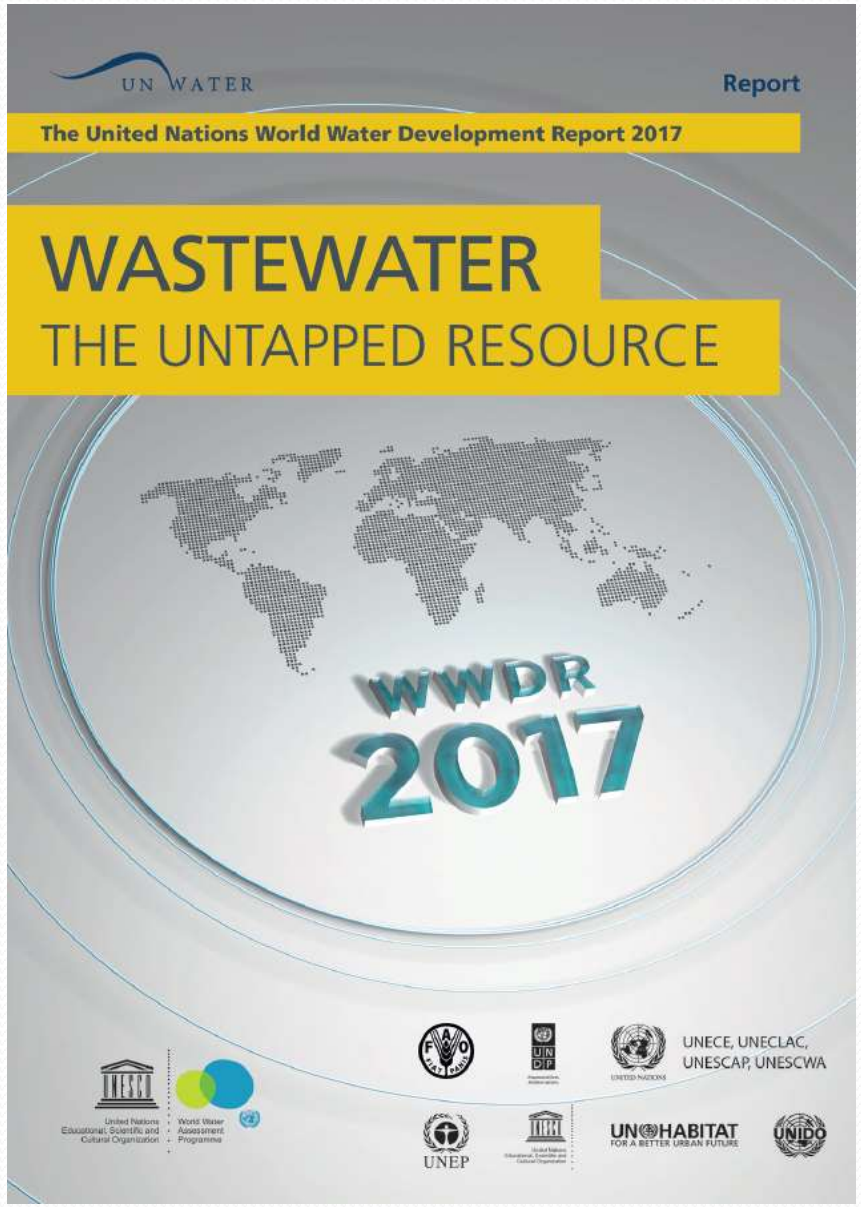
International Hydrological Programme

IHP- VIII 2014-2021

Water Security: Response to Global, Regional and Local Challenges



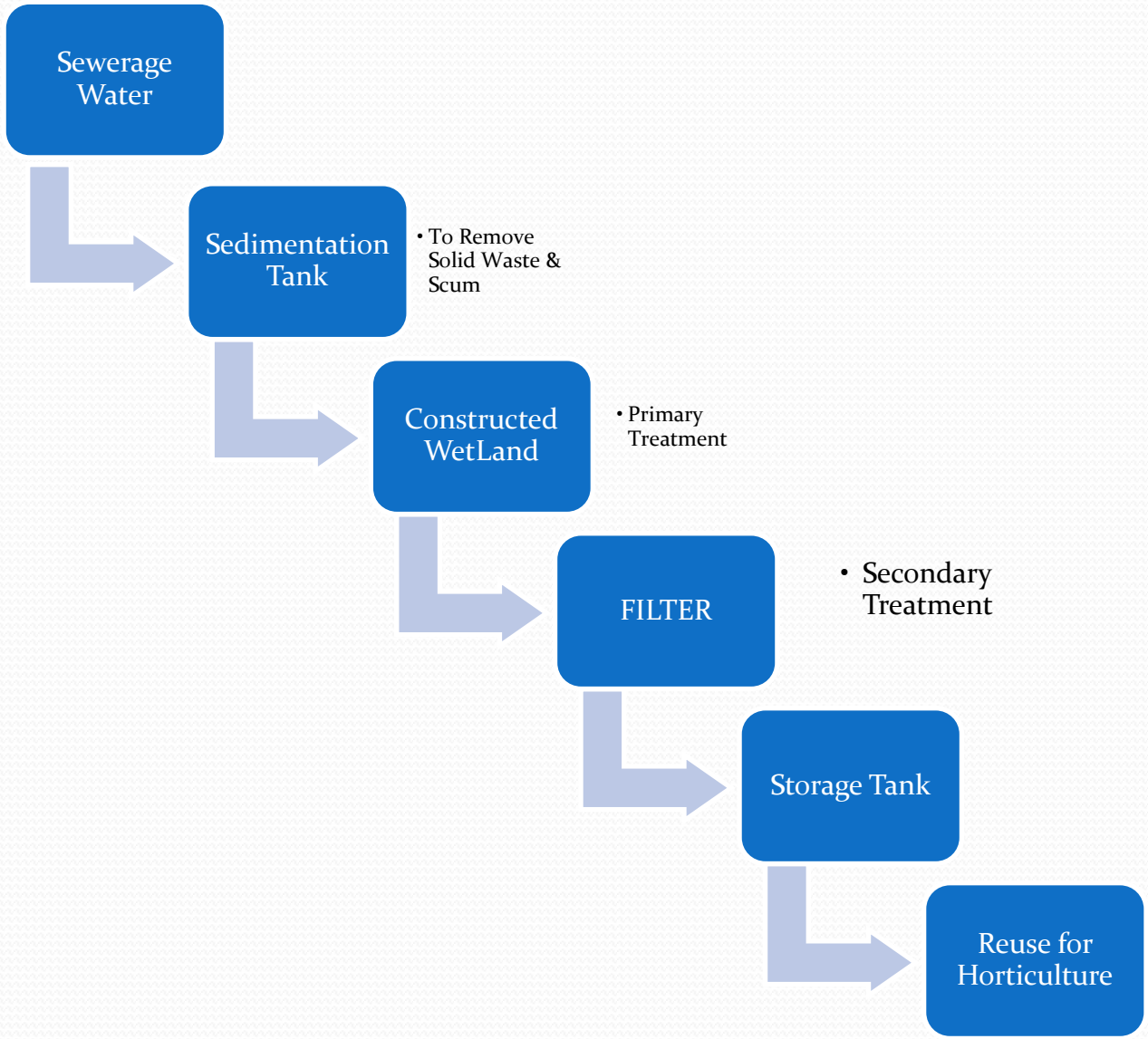
Improved wastewater management generates social, environmental and economic benefits, and is essential to achieving the 2030 Agenda for Sustainable Development.

Target 6.3 of the Sustainable Development Goals (SDGs) explicitly focuses on reducing pollution and its impact on ambient water quality by increasing the treatment and safe use of wastewater globally. This target is highly relevant to achieving several other SDGs.

Use of Bioremediation Technologies at NUST Islamabad Campus

- UNESCO in partnership with NUST Institute of Civil Engineering (NICE) implemented a project to demonstrate the use of Bioremediation based CW-FILTER technologies at its Islamabad Campus
- Wastewater generated from offices, student hostels and staff residential colony located at NUST Islamabad Campus is led towards a Sedimentation Tank and then to a Constructed Wetland (comprising of eight compartments) where wastewater quality is improved through bioremediation
- The quality of effluent from the Constructed Wetland is further improved by use of FILTER (Filtration and Irrigated cropping for Land Treatment and Effluent Reuse) technique

Flow Chart


Sewerage Water
Sedimentation Tank
• To Remove Solid Waste & Scum
Constructed WetLand
• Primary Treatment
FILTER
• Secondary Treatment
Storage Tank
Reuse for Horticulture

Study Site

Location:	Northern Corner of NUST H-12 Campus, Islamabad at Latitude 33.6417767, and Longitude 73.0035925
Treatment Capacity:	50,000 – 75,000 Gallons/Day
Sedimentation Tank:	35 ft x 12 ft x 6 ft.
Detention Period :	3 – 4 hours
Constructed Wetland:	120 ft. x 100 ft. (8 x compartments each of 22 ft. x 50 ft.)
Emergent/floating/ submergent vegetation:	Typha, Water lettuce, Common Reed, Duckweed, Pennywort
FILTER:	120 ft. x 170 ft
Cost of Project:	USD $ 65,000
Project Sponsored By:	UNESCO

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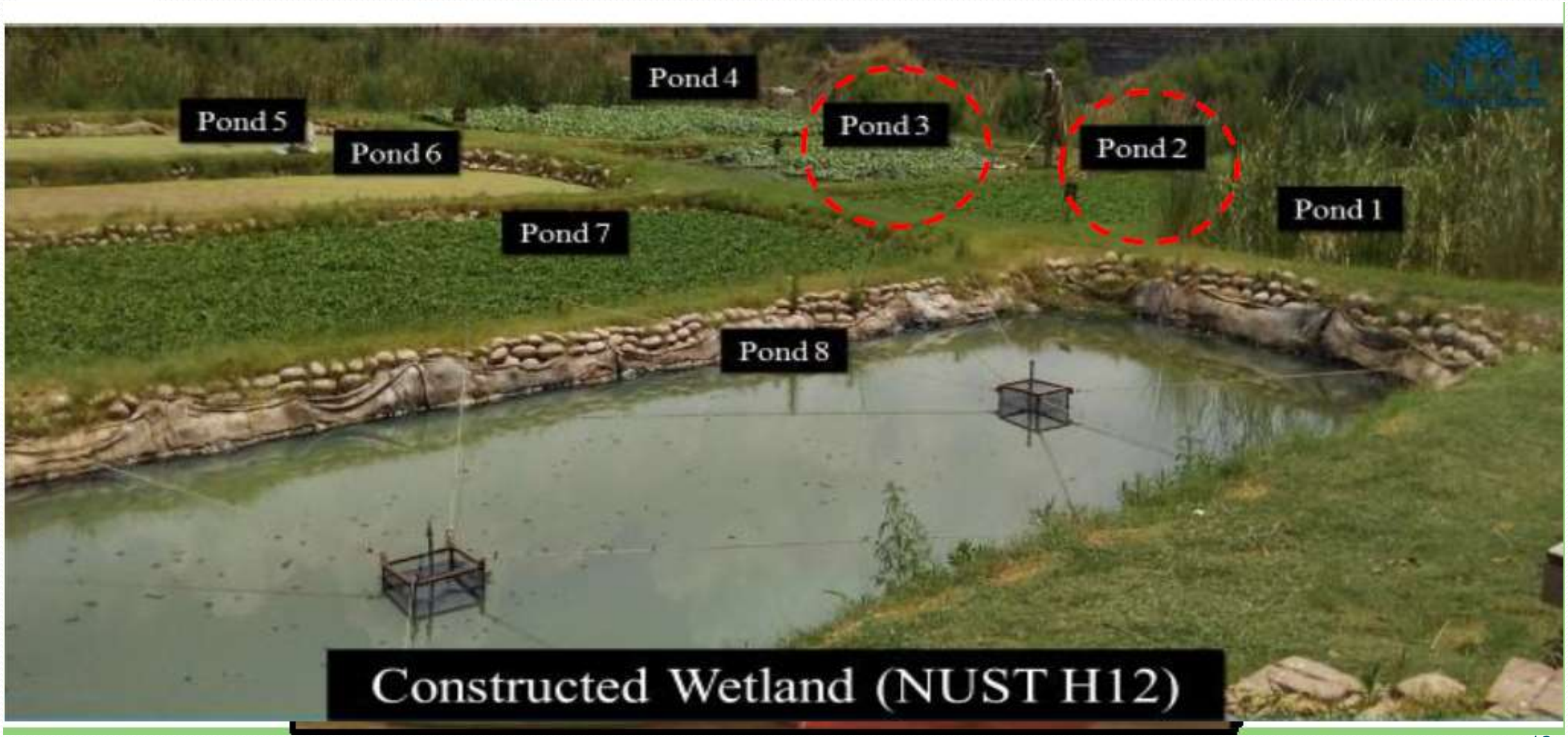

Introduction to FILTER

- FILTER (Filtration and Irrigated Cropping for Land Treatment and Effluent Reuse) technique was developed at CSIRO in Australia. It has been successfully tested both in Australia and China.

- Wastewater can be treated in a relatively small area of land with selected crops so that pollution of agricultural produce and health risks due to large-scale wastewater irrigation can be prevented

- The FILTER technique combines using the nutrient rich effluent or wastewater for intensive annual cropping

- It provides wastewater treatment throughout the year, thereby eliminating the need for expensive wastewater storage

- The treated wastewater can be reused for irrigation or discharged to water bodies meeting the EPA requirements

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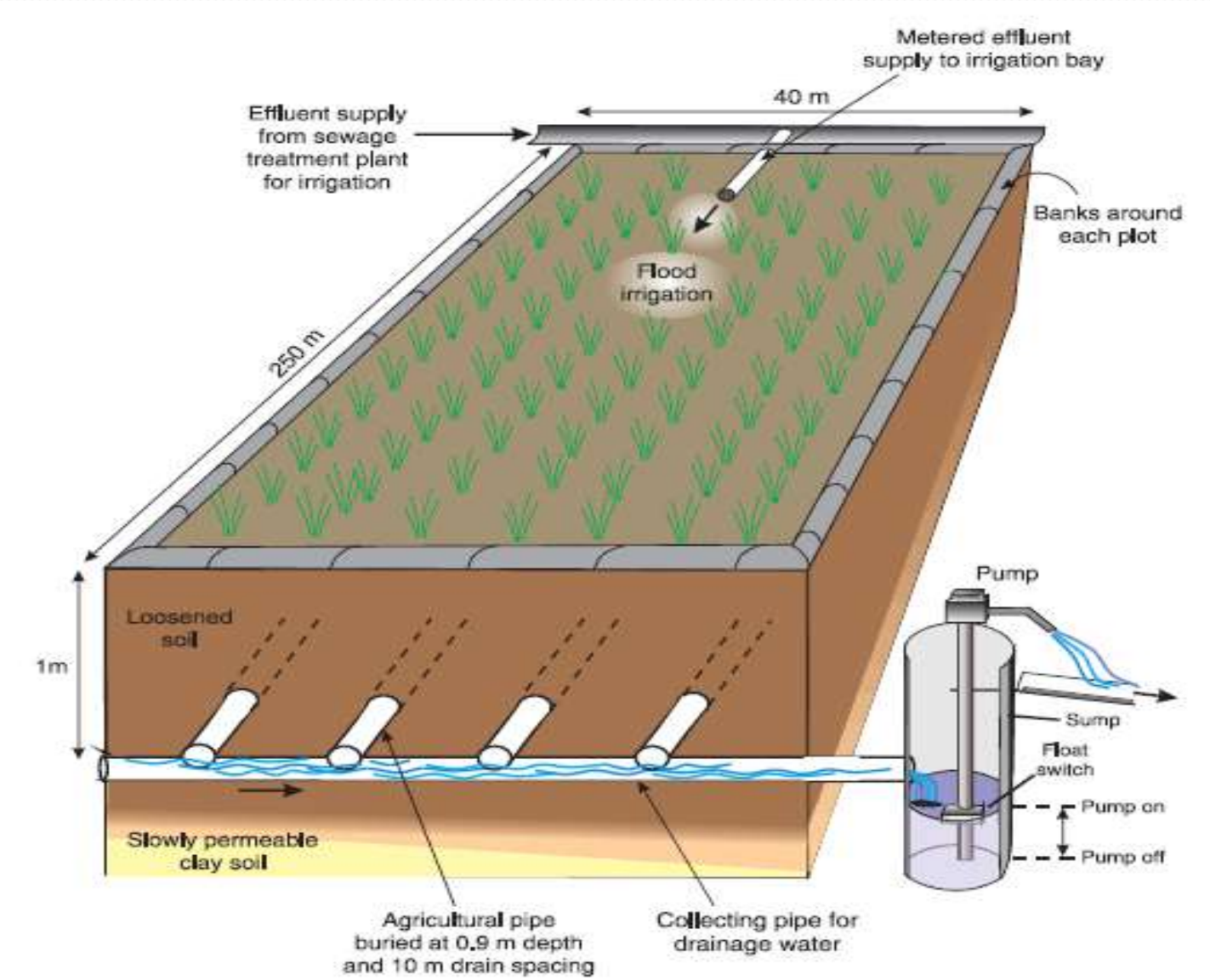

Schematic diagram of FILTER plots

Salient Features of FILTER

- Size of FILTER: 120 ft. x 170 ft.
- FILTER Design Parameters:
  - ✓ Drainage Coefficient = 0.5 inches/day
  - ✓ Tile Drain (Lateral) Diameter = 4 inches, Collector Diameter = 6 inches
  - ✓ Tile Drain Depth = 3 ft
  - ✓ Depth to Restrictive Layer (LDPE) = 5 ft
  - ✓ Minimum Water Table Depth = 1 ft
  - ✓ Saturated Hydraulic Conductivity = 0.24 ft/day
  - ✓ Drain Spacing = 15 ft.

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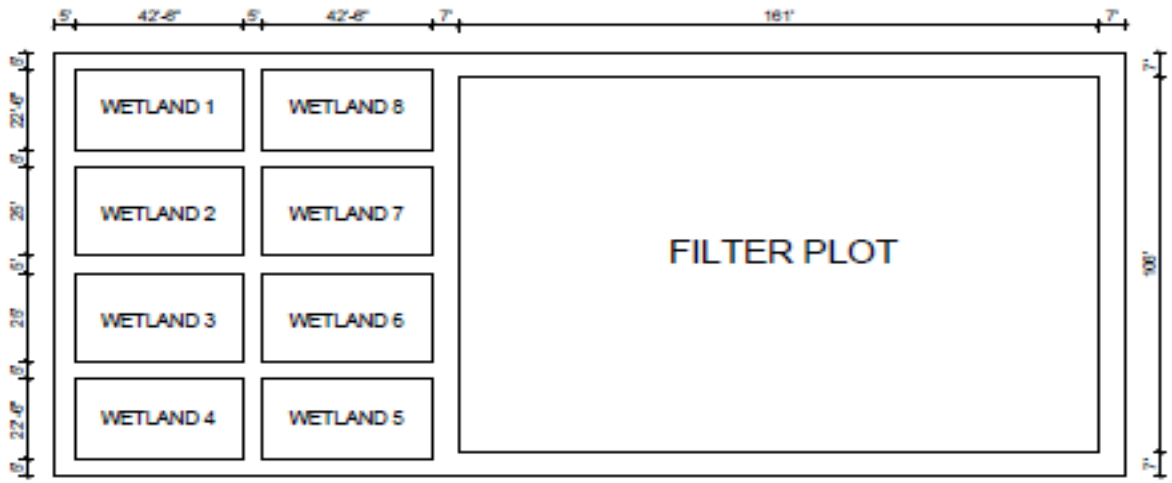

FILTER PLAN
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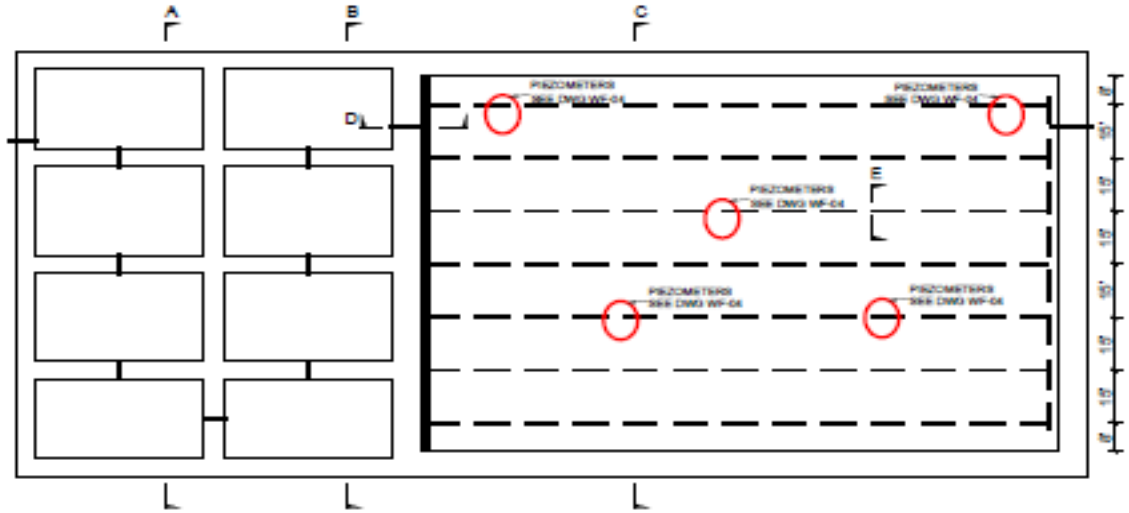

TILE DRAINS
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GENERAL NOTES

THE CONTRACTOR SHALL NOT PROCEED WITH THE CONSTRUCTION WITHOUT APPROVAL OF THE ENGINEER

WATER LEVELS ARE SAME IN ALL WETLANDS. FILTER PLOT HAS WATER LEVEL 3" LESS THAN THE WETLANDS

TILE DRAINS ENCLOSED IN 6" GRAVEL ALL AROUND

AWARDEE
NATIONAL UNIVERSITY OF SCIENCES AND TECHNOLOGY (NUST)

PROJECT
UNESCO-NUST FILTER PROJECT

CLIENT
UNESCO

TITLE
WETLANDS & FILTER PLOT DETAILS

DETAILS

DWG. NO.	WF-01
REVISION	0
SCALE	1:400

WASTE WATER TREATMENT

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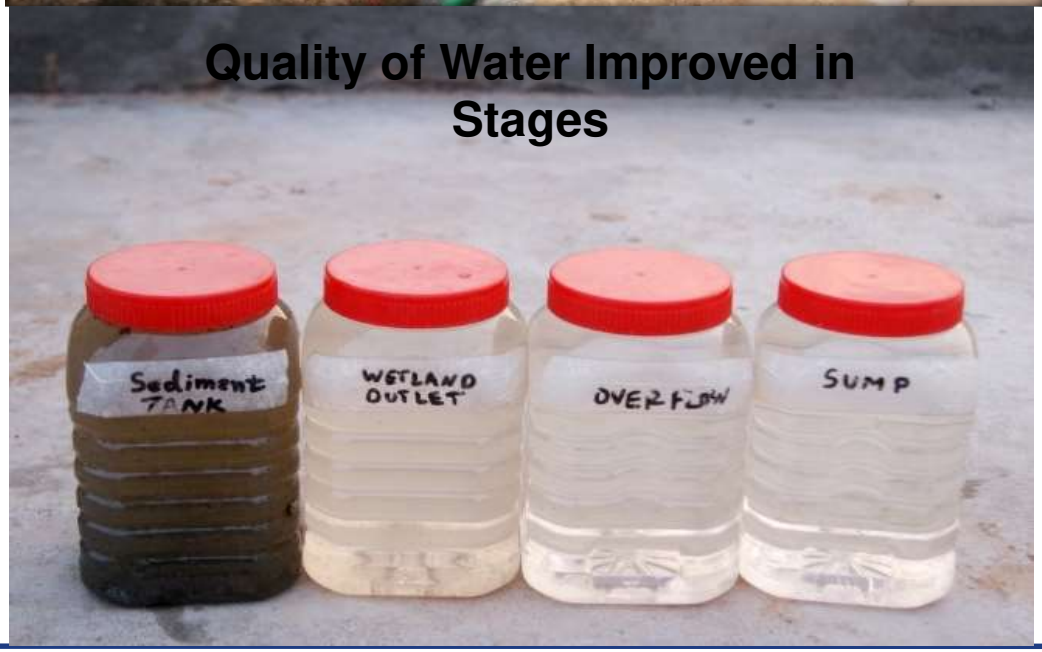
Tile Drains in FILTER

FILTER in Operation

Quality of Water Improved in Stages



Storage Tank for Treated Water

WASTE WATER TREATMENT

Filled with Recycled Water

Recycled Water Used for Horticulture

Guava Trees

Guava Trees

Conclusions

- The monitoring of CW-FILTER system shows that their general performance was good and they **successfully reduced contaminants**
- The results indicate that if technologies based on principles of bioremediation are **appropriately designed and operated**, they can be used for secondary and tertiary wastewater treatment under local conditions, successfully
- Bioremediation based technologies can be used instead of expensive mechanized wastewater treatment plants, especially in developing countries as they are **cheaper, robust and easy to operate**
- At least **75000 gallons / day of recycled water available** for horticulture and as it is satisfactorily **meeting the US EPA Limits / Pakistan National Environmental Quality Standards (NEQS)**

Conclusions

- Reduction of **health hazards**
- **Improved ecology** of surrounding environment
- Conservation of **stressed ground water aquifer**
- Gravity flow results in **Zero Energy required** for operation
- **Zero Waste** as collected solids usable as fertilizer
- Live size model **available for teaching and research**

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THANK YOU

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