

Decentralized Wastewater Treatment: A Paradigm Shift

विकेन्द्रीकरण दूषित जल उपचार संयंत्र:
एक प्रतिमान विस्थापन

Online Training on 'Offsite and Onsite Management of Sewage for
Citywide Sanitation,
13-14 January 2021



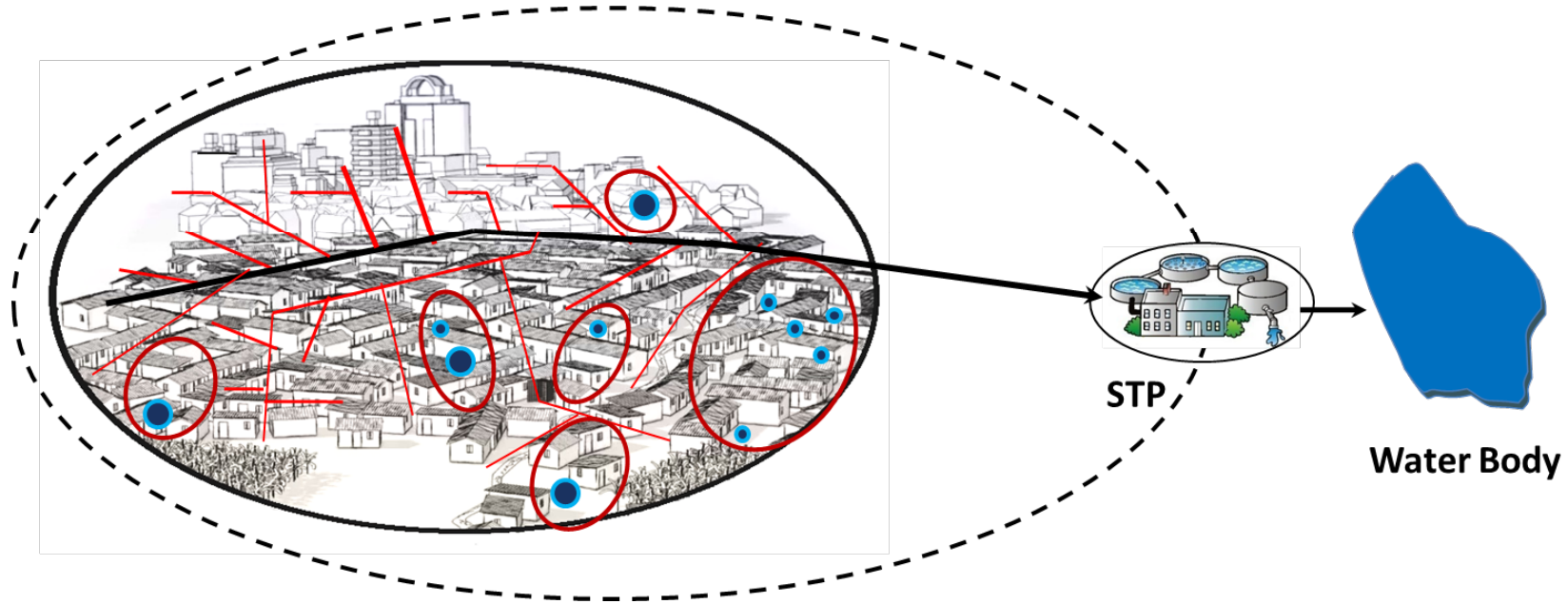
STRUCTURE

संरचना

- Concept, Principle and Scale of Intervention of the alternative approach in Urban Setting (शहरों की स्थापना में दुसरे विकल्पो की संकल्पना, सिद्धांत, हस्ताक्षेप के पैमाने)
- Importance of Decentralized Wastewater Treatment in Citywide Water and Sanitation (विकेन्द्रीकरण दूषित जल उपचार संयंत्र का महत्त्व)
- Showcasing Best Practices of various DWWTs (विभिन्न विकेन्द्रिकरण दूषित जल उपचार संयंत्र की सर्वोत्तम प्रथाएं)

Urban Wastewater Management: How we conventionally plan our cities?

शहरी दूषित जल उपचार संयंत्र: कैसे प्रथानुसार शहरो की योजना बनाये?



Cities plan for water, forget waste (शहरों में जल की योजना बनायीं जाती है, अपशिष्ट की नहीं)



Most of our cities do not have underground sewerage

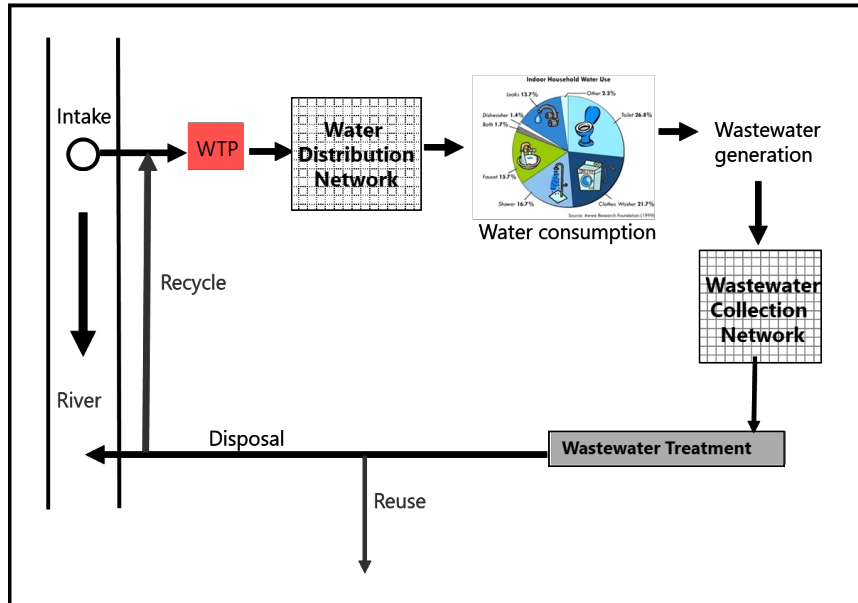
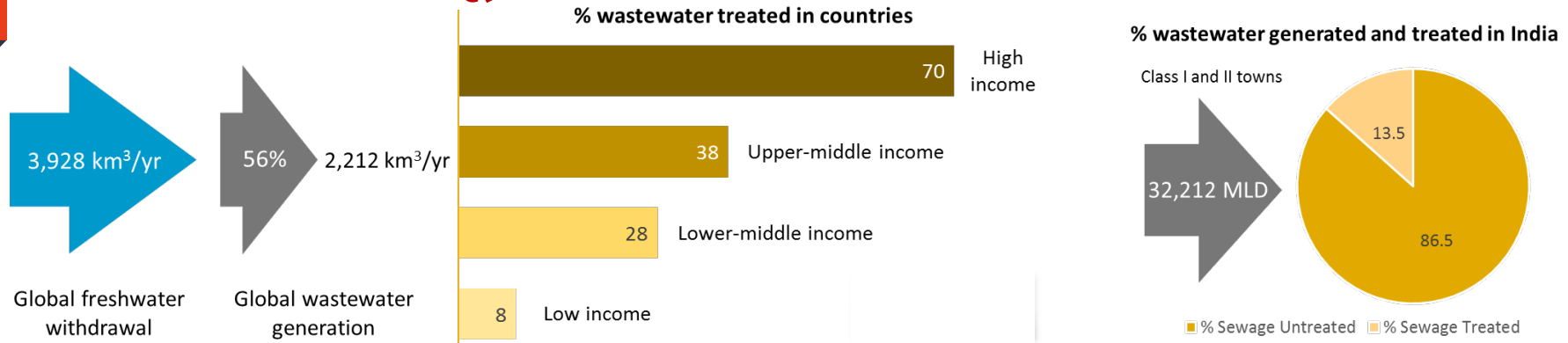
Where there is pipeline; broken; sewage does not reach treatment plants

Most treatment plants are under-utilized

We lose rivers

Current Approach of Water and Wastewater Management

जल और दूषित जल का संचार का वर्तमान दृष्टिकोण



- Infrastructure-intensive (गहन आधारिक संरचना)
- **Energy intensive** - extraction, storage, distribution, collection and conveyance systems (गहन उर्जा)
- Average leakage loss ratio in developing countries: **40–50%** in large metropolitan cities, and **50–60%** in smaller cities. (औसत रिसाव की कमी अनुपात, विकासशील देश – 40-50% महानगरो में, 50-60% छोटे शहर)
- Most of the transmission and distribution pipelines are very old, and many of them are corroded and leaking, resulting in **increased water losses and inadequate water quality**. (पुरानी पारेषण पाइपलाइन की पानी का रिसाव होना)
- Carbon Emissions (कार्बन उत्सर्जन)

Need for a Paradigm Shift

एक प्रतिमानी बदलाव की ज़रूरत

WHAT IS

“Decentralised wastewater management (DWWM) is defined as the **collection, treatment and disposal / reuse of wastewater at or near the point of waste generation.**”

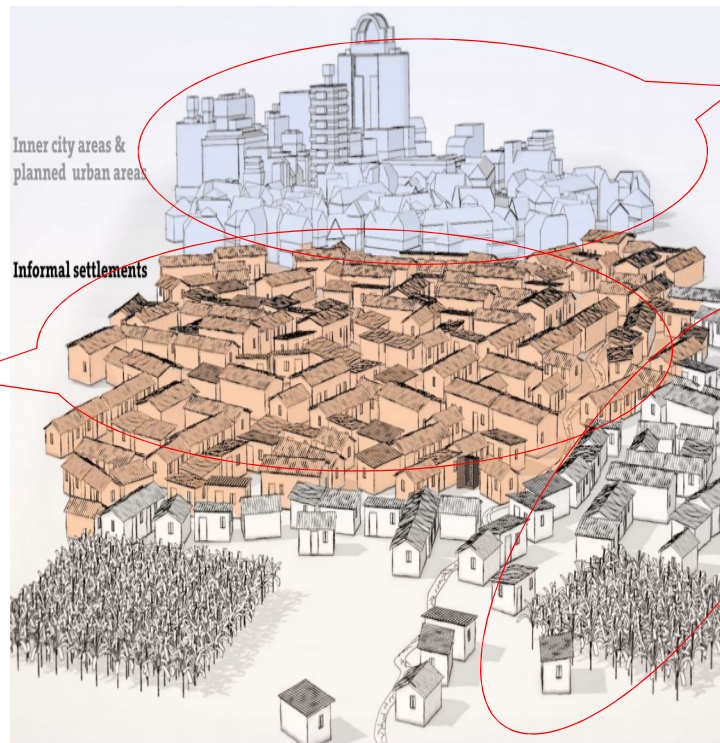
(विकेंद्रिकरण दूषित जल उपचार संयंत्र द्वारा अपशिष्ट जल का संग्रह, उपचार, निपटन/ पुनःउपयोग किया जाता है अपशिष्ट उत्पादन होने वाले स्थान पर ही)

It includes systems that treat wastewater from individual homes, cluster of homes, isolated communities, industries or institutional facilities as well as portion of existing communities

PRINCIPLE

Decentralised wastewater treatment (DWWT) is based on the important principle – **devolving level of the application** so that wastewater can be treated at **affordable costs, cutting the cost of pumping long distances and promoting local reuse of treated wastewater.**

Onsite
Sanitation



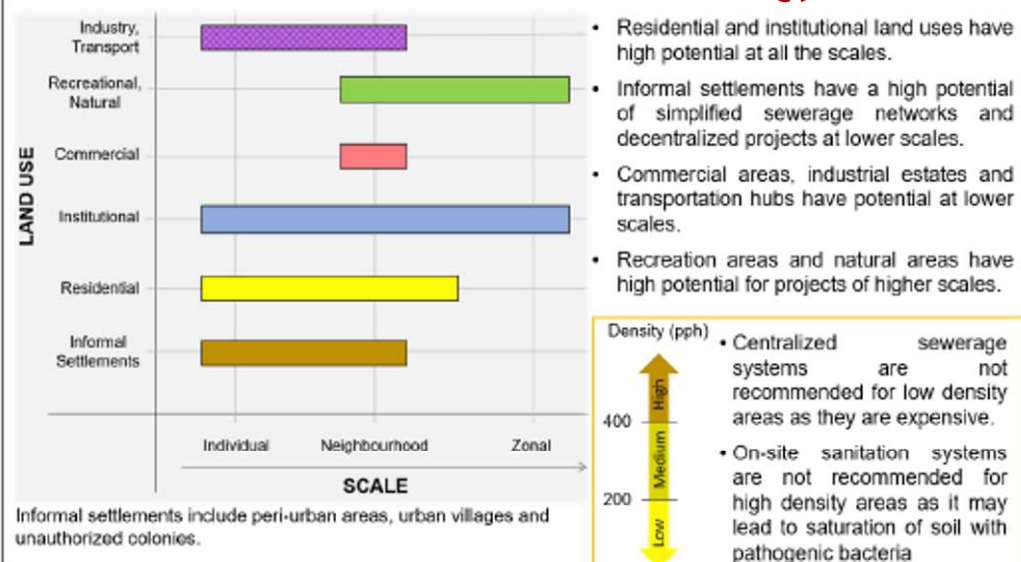
Sewer
Connection

New
Settlements

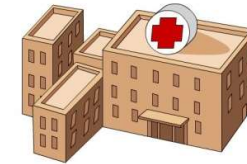


Scales of Decentralized Wastewater Management

(विकेन्द्रिकरण दूषित जल उपचार संयंत्र के स्तर)



Public toilets



Hospitals



Single house



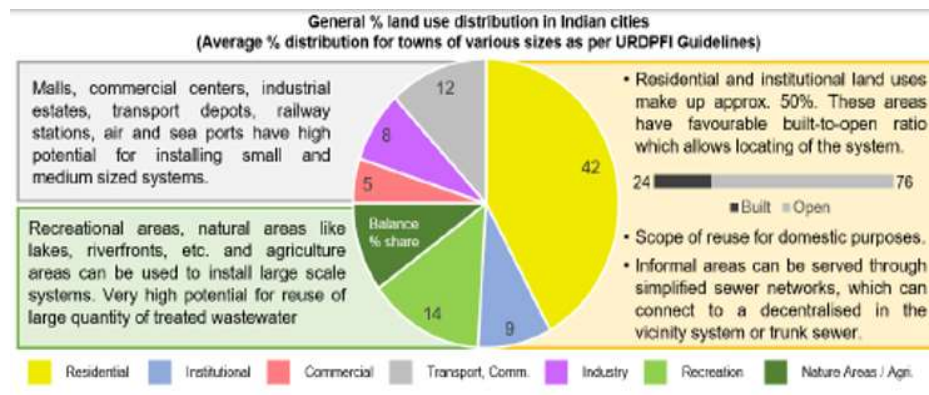
Residential areas



Markets/Offices



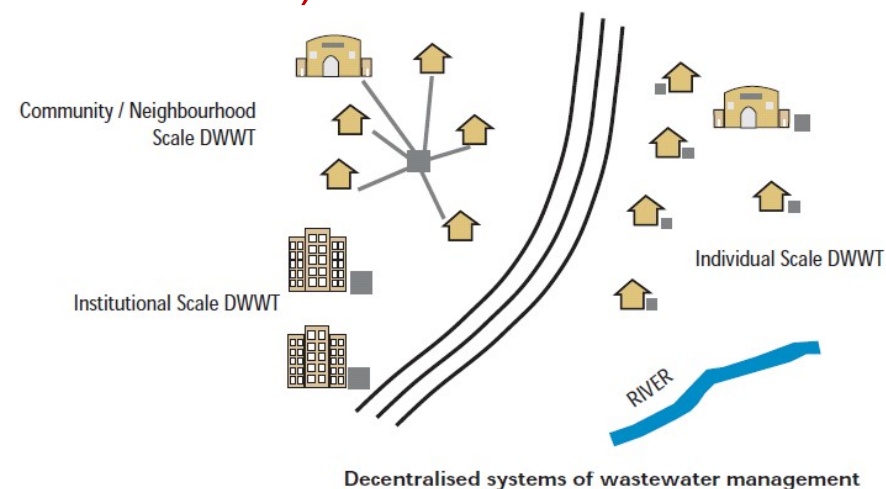
Schools/colleges



Scales of Decentralized Wastewater Management

(विकेन्द्रिकरण दूषित जल उपचार संयंत्र के स्तर)

Scales	City/zonal scale	Neighbourhood / Institutional scale	Individual scale
Areas (sq. m)	10,000–15,000	4,000–5,000	1,000–4,000
Users/population	5,000 (maximum)	200–5,000	5–200
Wastewater generation capacity (kilolitre per day—KLD)	500 (maximum)	20–500	0.5–20
Land uses/activities	Medium density: 200–400 persons per hectare (pph), commercial areas, neighbourhoods, institutional and peri-urban areas	Institutional/ commercial buildings	Residential buildings (plotted/four–five storied)



Approach depends on (दृष्टिकोण निर्भर करता है)

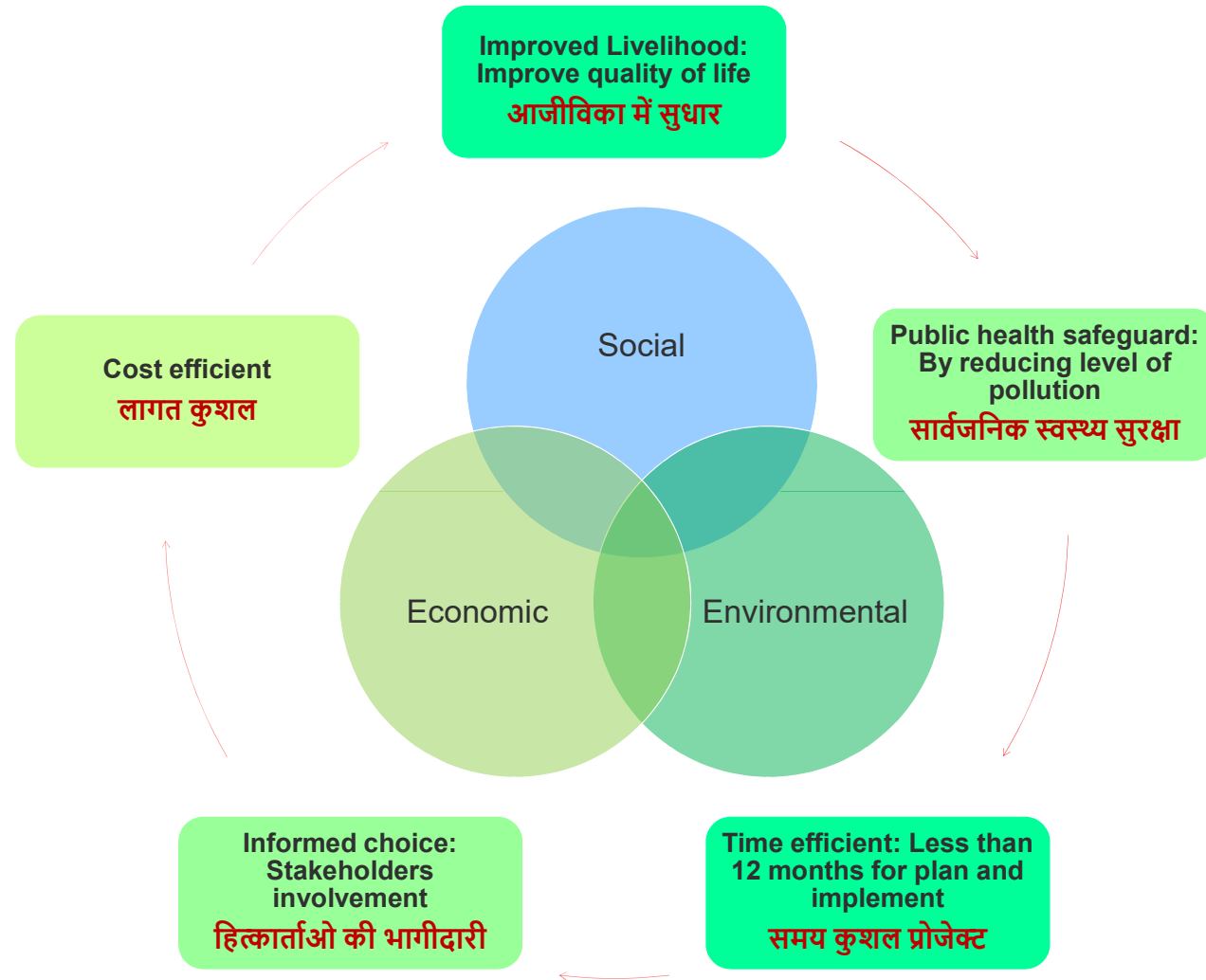
- Area (क्षेत्र)
- Size and density of the population (जनसंख्या घनत्व)
- Level of economic development (आर्थिक विकास का स्तर)
- Technical capacity and system of governance in place (सरकार की तकनीकी क्षमता)
- Quality required for end users or that required for safe disposal

DWWT Characteristics and Advantages

(विकेन्द्रिकरण दूषित जल उपचार संयंत्र की विशेषताएँ और लाभ)

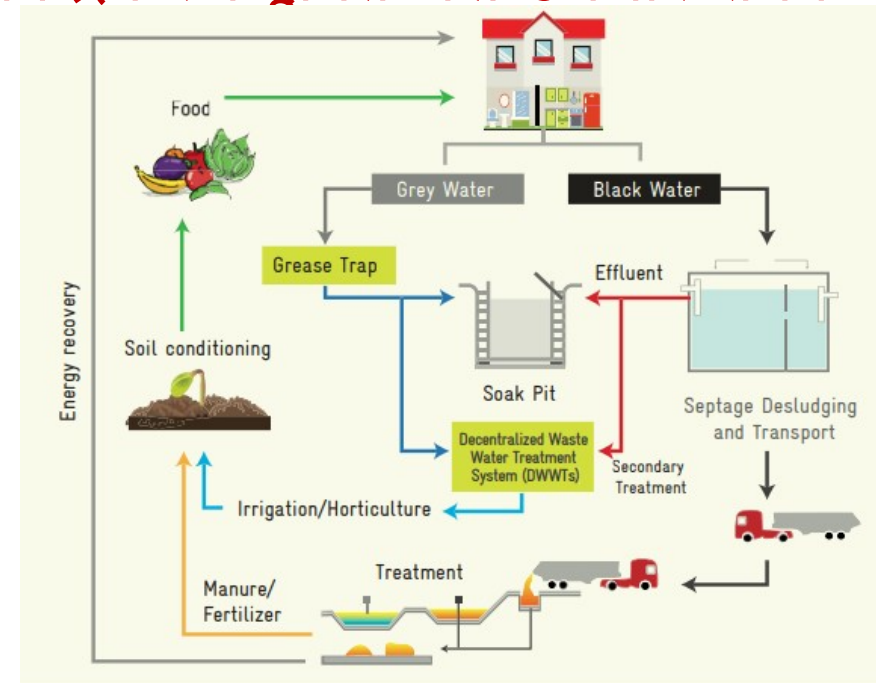
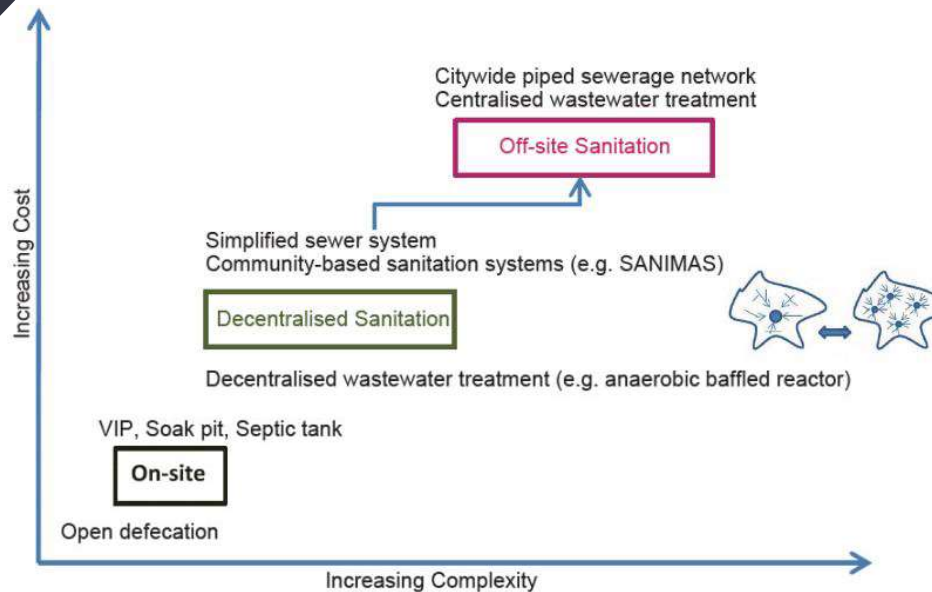
- 
Cut / Reduce the length of pipeline (पाइपलाइन की लम्बाई कम)
 Wastewater can be **treated on site**, no need of conveying to far distances. **Sewer networks are shorter in length and smaller in diameter** since there are several disposal points
- 
Required basic skills to operate and maintain (बुनियादी कौशल की ज़रूरत)
Semi skilled/ unskilled labour required for operation and maintenance.
- 
Reduces carbon footprint (कार्बन फुटप्रिंट कम होता है)
 Generally **less or no energy required**. Also no addition of expensive chemicals or additives
- 
Safe reuse of treated wastewater (उपचारित दूषित जल का सुरक्षित पुनःउपयोग)
Especially for non potable end uses
- 
Cost efficient (लागत कुशल)
 Doesn't require **sophisticated or costly maintenance**
- 
Promotes a kind of 'public-private partnership' (सरकारी और निजी भागीदारी को प्रोत्साहन)
 ULBs / local authorities have to provide lesser capital outlay including low O&M that is taken care by public
- 
Adaptability in nature (स्वभाव में अनुकूलता)
 Adaptable to **varying organic load and climatic condition**
- 
Suitable for Organic wastewater flow (जैविक दूषित जल के बहाव के लिए उपयुक्त)
1-1,000 m3 per day
- 
Meets the wastewater standards (दूषित जल के मानक को पूरा करता है)
 Treated wastewater **meets the discharge standards** and environmental laws
- 
Follows circular economy (परिपत्र अर्थव्यवस्था को पालन करता है)
 Treat and reuse of **wastewater locally and promotes resource recovery**
- 
Doesn't cause any nuisance (बाधाहीन)
 Such as **noise pollution, bad odour to the surrounding, problems of mosquito breeding** etc.
- 
Site specific and flexible in nature (साईट विशिष्ट)
 To be designed **according to the characteristics of wastewater**

Benefits of DWWTs (विकेन्द्रिकरण दूषित जल उपचार संयंत्र के फायदे)



Missing Link: Decentralized Wastewater Treatment in Sanitation

लापता कड़ी: सैनिटेशन सेक्टर में विकेन्द्रिकरण दूषित जल उपचार संयंत्र



Decentralized approach bridges the gap between OSS and conventional off-site sanitation approaches
विकेन्द्रिकरण दृष्टिकोण अपनाने से ऑनसाइट सैनिटेशन एवं परम्परागत ऑफसाइट सैनिटेशन के बीच के गैप को पाटता है

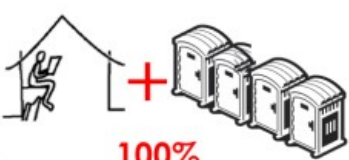
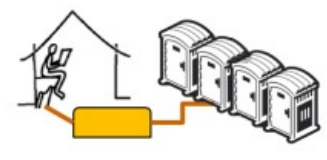
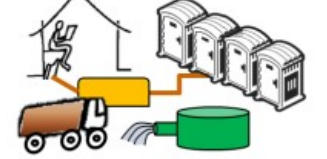
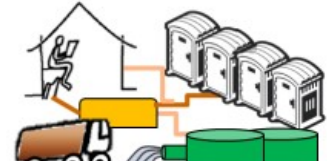
- The decentralized approach is also applicable to address the **issue of environmental pollution** caused by **effluent from the on-site sanitation systems**.
- The concept of **septage management** that sets out interlinked steps that are vital to manage septage and effluent from **generation to disposal to end-use** also recognize **DWWM** as one of the solution for effluent management.

DWWM approach talks beyond Toilets

विकेन्द्रिकरण दूषित जल उपचार संयंत्र दृष्टिकोण शौचालय से आगे की बात करता है

ODF+ and ODF++ are aimed towards proper maintenance of toilet facilities and safe collection, conveyance, treatment/disposal of all faecal sludge and sewage

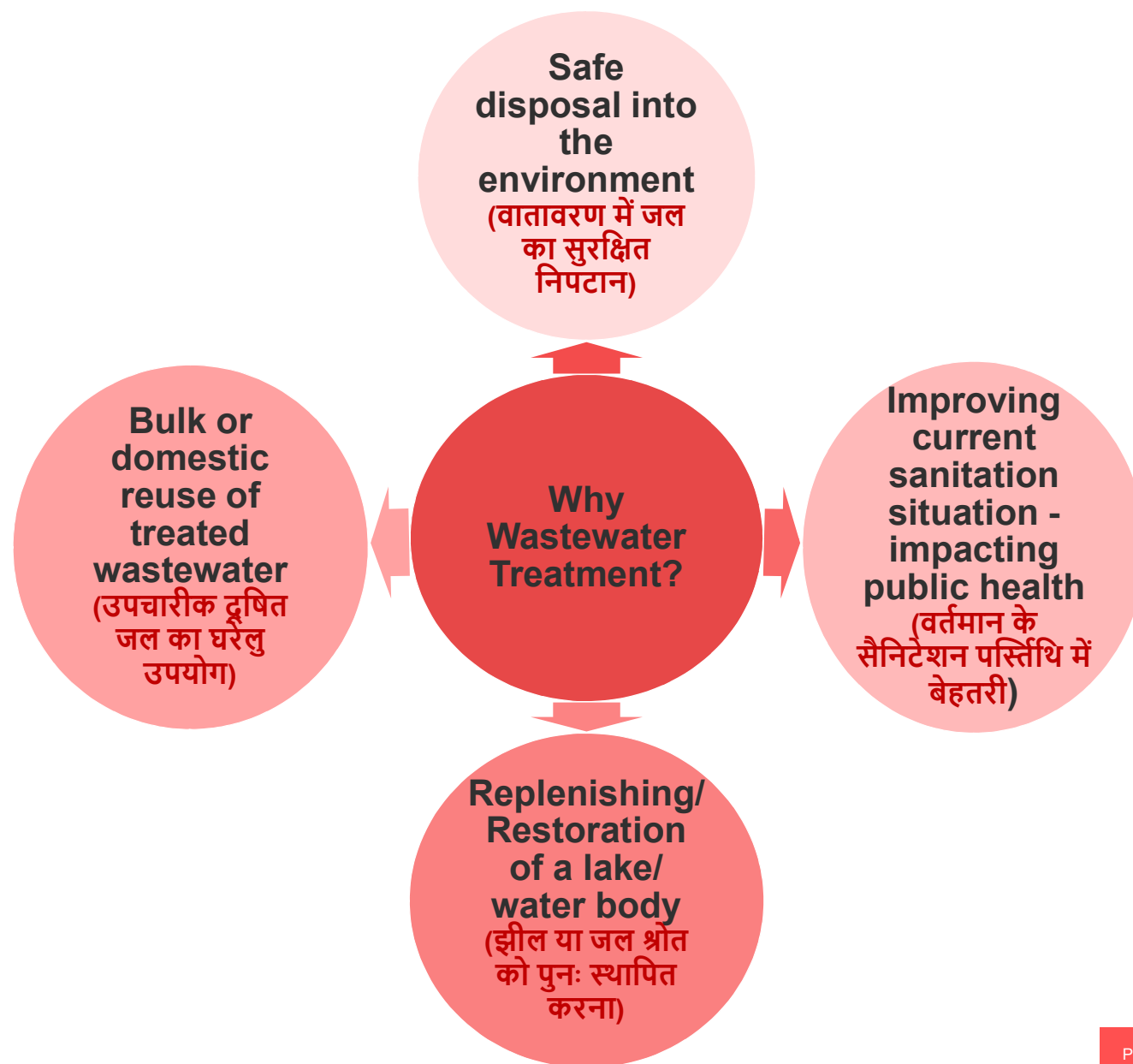
- ODF+ focuses on toilets with water, maintenance and hygiene (ODF+ शौचालय, जल की व्यवस्था और स्वच्छता पर जोर देता है)
- ODF++ focuses on toilets with sludge and septage management hygiene (ODF++ में शौचालय और फेकल स्लज और सेप्टेज प्रबंधन पर जोर है)

ODF	 No visible OD, faeces	 100% 100% access to own/community/public toilet	 All toilets connected to disposal system
	 No visible OD, faeces	 >80% <20% At least 80% access to own toilet; rest CT/PT	 All toilets connected to disposal system; safe collection conveyance and treatment
	 No visible OD, faeces	 >95% <5% At least 95% access to own toilet; rest CT/PT	 All toilets connected to disposal system; safe collection conveyance and treatment including effluent/grey water

Source: CEPT University

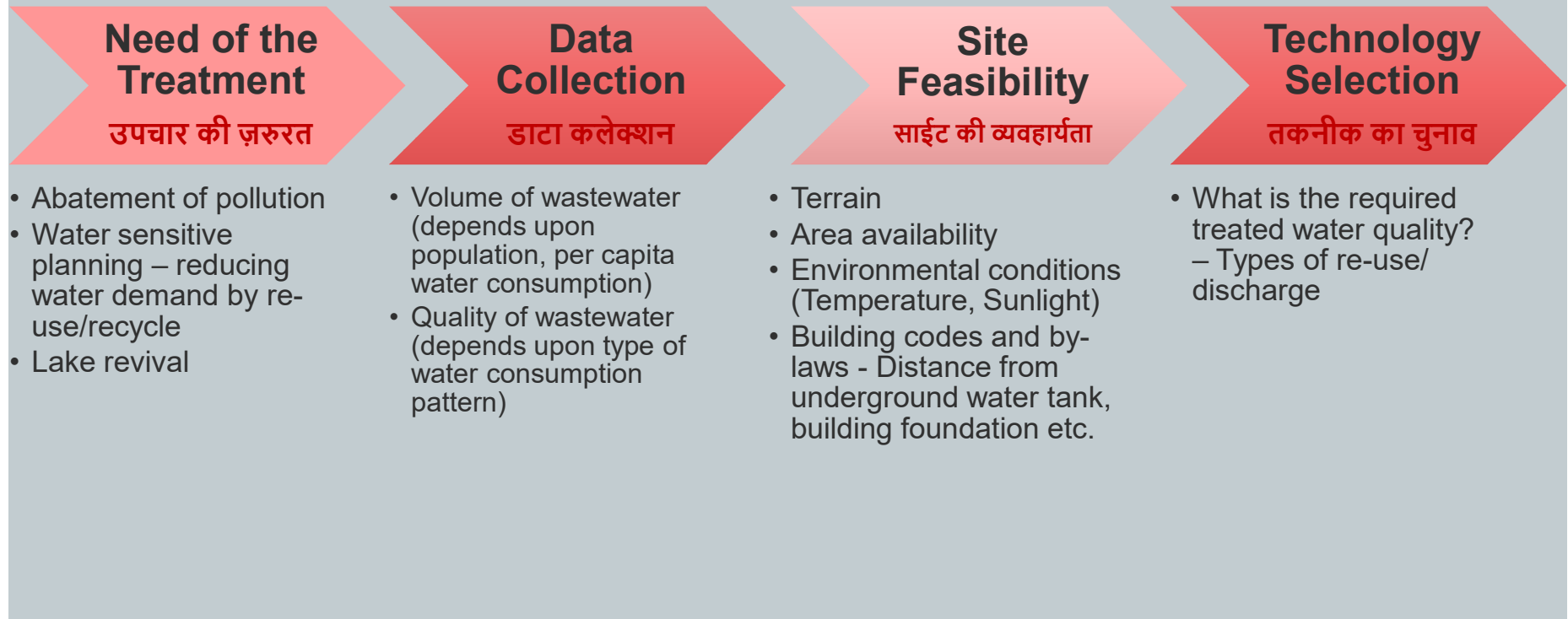
Why Wastewater Treatment?

दूषित जल का उपचार क्यों?



Process flow for setting up DWWTs

विकेन्द्रिकरण दूषित जल उपचार संयंत्र लगाने की प्रक्रिया



Data Collection

डाटा कलेक्शन

Flow of wastewater दूषित जल का बहाव

- Population
- Per capita water consumption
- Volume of wastewater generation

Quality of wastewater दूषित जल की गुणवत्ता

- Type of water consumption pattern
- Quality analysis report
- Physical appearance of wastewater

Volume of wastewater generated /day (cum)

Thumb rule: 80% of the total water consumption goes out as waste

Example:

Population (P) = 130,

Water use = 100 litres / capita / day

Volume of water consumed

$$= 130 \times 100 = 13000 \text{ litres / day or } 13 \text{ cum/ day}$$

Hence average volume of wastewater generated

$$= 13000 \times 0.8 = 10,400 \text{ litres /day or approx. } 10 \text{ cum/ day.}$$

Site Feasibility

साईट की व्यवहार्यता

Terrain

Soil मिट्टी

Ground water भूजल

Topography तलरूप

High ground water level

Construction of DWWT is challenging

Scope of possible leakage of untreated sewage into ground water

DWWT system should be strictly waterproof

Topography – high altitude, steep terrain

High pumping requirements for water

Sewer can be gravity driven

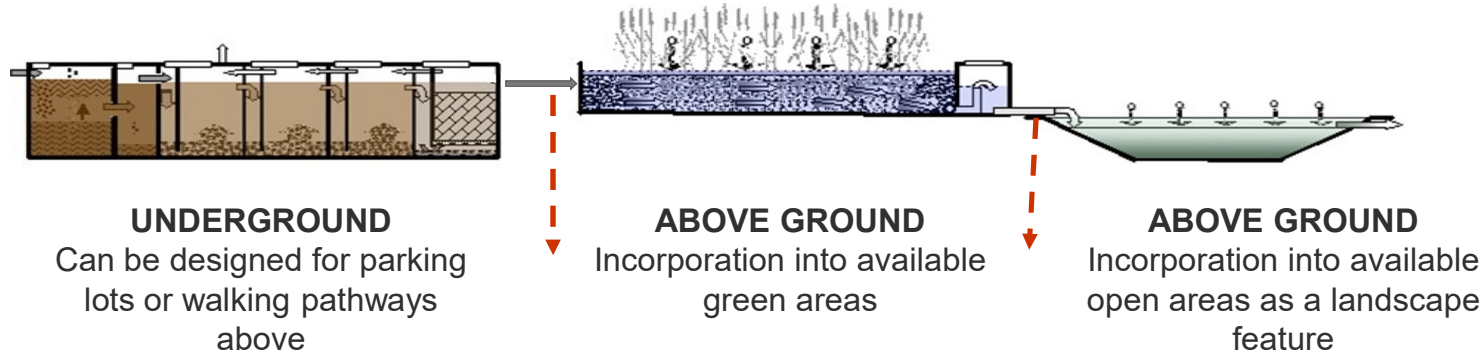


Site Feasibility

साईट की व्यवहार्यता

Things to keep in mind while planning a DWWTs:

- Land ownership? Is there any land dispute? भूमि का स्वामित्व? कोई ज़मीनी मतभेद?
- What are the constraints? बाकी बाधाएं?
- Is there any service and utility infrastructure that could get affected? किसी सर्विस या आधारीक संरचना में प्रभाव पड़ना?
- How much surface area available कितना सतह क्षेत्र उपलब्ध है?
- Are there any opportunity areas – available open spaces? खुली सतह उपलब्ध है?
- Try to utilize set-back area
- Incorporation as a landscape feature परिदृश्य जैसा सम्मिलित करना



Objectives of the Treatment

उपचार करने के
उद्देश्य

The objective of wastewater treatment is to extract pollutants, remove toxicants & coarse particles, reduce organic & nutrient load, kill pathogens so that quality of effluent is improved to reach the permissible level of water to be reused.

Selection of treatment options based on achievement of following objectives

Pathogen Removal

रोगजनक निष्कासन

Organic Load
Reduction

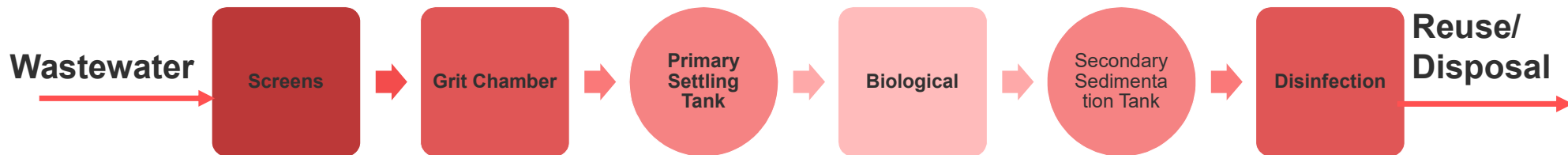
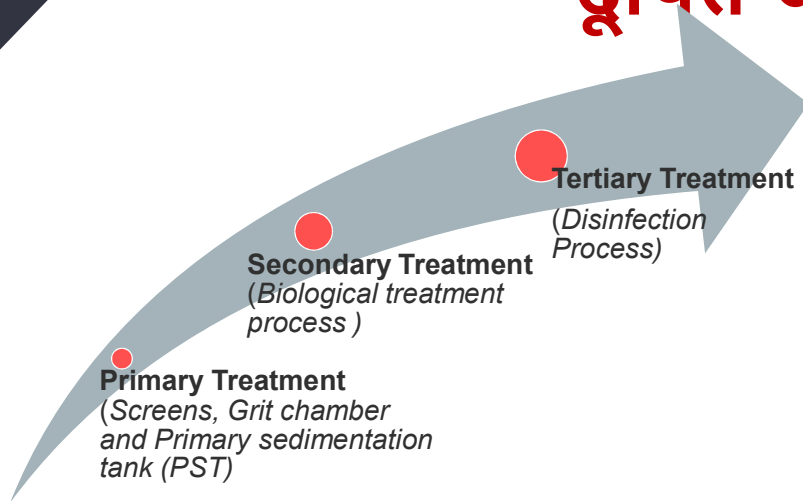
जैविक भार में कमी

Reuse

पुनः
उपयोग

Stages of Wastewater Treatment

दूषित जल के उपचार के चरण



Nature based Decentralized Wastewater Treatment Technologies

Name of the technology	Reuse of treated water	Capital cost (INR/KLD)	O&M cost (INR/KLD/ year)
Constructed Wetland	Horticulture	10000	1500-2000
DWWTs	Horticulture	50000	8500
Green bridge	In situ treatment of water bodies	200-500	20-50
Biosanitizer/ Eco chip	In situ treatment of water bodies, Horticulture	10000 per chip excluding construction cost	-
Nualgi	In situ treatment of lakes/ ponds, Increase in fish yield	0.35	9-10
Bioremediation	In situ treatment of lakes/ ponds	225 – 300	200 – 225
Soil scape filter	Horticulture	20000-30000	1800 – 2000
Fixed film biofilter Technology (FFBT)	Horticulture/ Car washing	25,000-35,000	1,000-2,000
Phytoid	Horticulture	14,000-35,000	1,000-2,000

Electro-mechanical Decentralized Wastewater Treatment Technologies

Name of the technology	Treatment capacity	Reuse of treated water	Capital cost (INR/KLD)	O&M cost (INR/KLD/ year)
Soil Bio technology (SBT)	5KLD – tens of MLD	Horticulture Cooling systems	10,000-15,000	1000-1500
Trans Biofilter	5 KLD-3 MLD	Gardening, landscaping, farming & other non-potable purposes	50-70	5-7
Tiger Biofilter	15 KLD-500 KLD	Washing, flushing, construction, and gardening	25000-30000	1800-2000

Criteria: Selection of Technology

The ideal technology should satisfy all of the following criteria

Parameter Consideration	Goal
Treated effluent quality	The technology must meet the standards as required
Energy requirement	The process choice should consider minimizing energy requirements
Land requirement	Minimize land requirement
Capital Cost of Plant	Process should allow optimum utilization of capital
Operational and Maintenance costs	Process design should be conductive to attaining lower running cost
Operation and Maintenance requirement	Simple and reliable
Reliability of System	Deliver the desired quality on a consistent basis
Reuse and Resource Recovery	Ability to maximize reuse of end products
Load Fluctuations	System should be able to withstand organic and hydraulic load fluctuations

Source: Guidelines for Decentralized Wastewater Management by IIT Madras



Menu on Un-networked Technologies

MOUNT is an aggregator platform for various sustainable technologies, encouraging and disseminating knowledge and good practices for wastewater management. MOUNT divides treatment process in 4 Categories

<https://www.cseindia.org/mount/home>

The screenshot displays the MOUNT website interface. At the top, there is a navigation bar with the MOUNT logo and links for HOME, MENU, SEARCH BY, RESOURCES, and CONTRIBUTE. Below this, four categories of treatment technologies are presented in colored boxes:

- Onsite Treatment** (Blue box): A facility (it may include user interface as well) that, in absence of sewerage network, collects and fully/partially treats the black water to allow for safe reuse or disposal of generated effluent.
- Decentralised Treatment** (Red box): A facility where domestic wastewater (both black and grey water) is treated close to the source at community or institutional scale to allow for safe local reuse or disposal of generated effluent.
- Faecal Sludge Treatment** (Orange box): A facility where the septage and/or faecal sludge is received (by vacuum trucks or otherwise) as an input and gets fully treated to allow for safe reuse or disposal of generated output (both solid and liquid).
- In-situ Treatment** (Green box): A facility where interventions are done at the receiving waterbody (like lakes, ponds and rivers) and/or open drains/nullahs itself for rejuvenation of the receiving water bodies.

Below these categories, there are four 'Search by' dropdown menus. The 'Decentralised Treatment' dropdown is expanded, showing a list of search terms:

- Sub Type of Technology
- Capital cost (Rupees / KLD)
- O&M (Rupees/KLD/ year)
- CAMUS - Soil Bio Technology
- Constructed Wetlands - Wastewater Treatment Systems
- Decentralised Wastewater Treatment Systems
- Fixed film biofilter technology
- Phytorid wastewater treatment system
- Soil Bio Technology (SBT)
- Tiger Bio Filter
- Trans Bio Filter

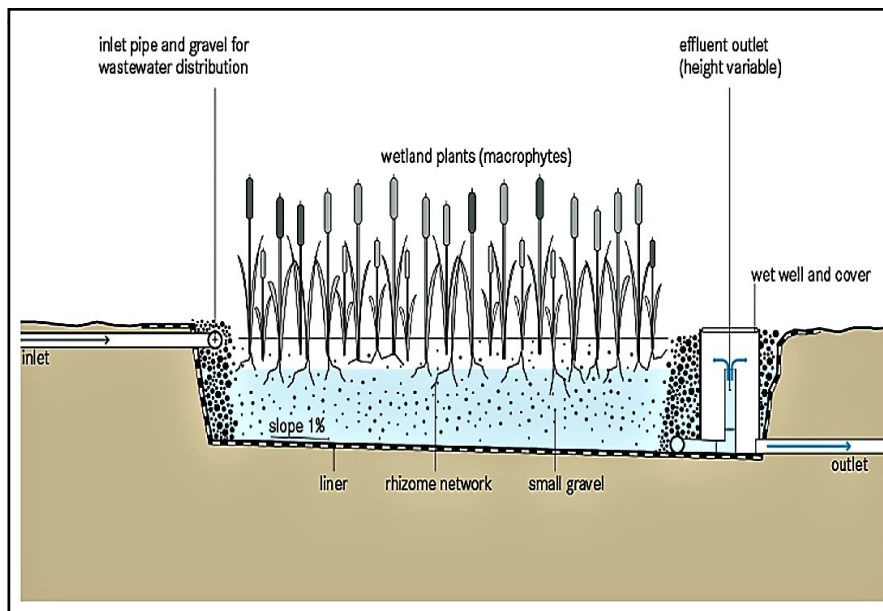
At the bottom, there is a map showing the location of Tashkent, Kyrgyzstan.

Constructed Wetland

A constructed wetland is an organic wastewater treatment system that mimics and improves the effectiveness of the processes that help to purify water similar to naturally occurring wetlands. The system uses **water, aquatic plants** (i.e. reeds, duckweed), **naturally occurring microorganisms** and a **filter bed** (usually of sand, soils and/or gravel).

The general concept is that **the plants, microorganisms and substrates** together act as a **filter and purification system**. First, water is slowed as it enters the wetland, **allowing for the sedimentation of solids**. **Through the process of water flow through the constructed wetland, plant roots and the substrate remove the larger particles present in the wastewater.**

Pollutants and nutrients present in the wastewater are then naturally broken down and taken **up by the bacteria and plants**, thereby removing them from the water. The retention time in the wetland, which varies depending on the design and desired quality level. After treatment in a constructed wetland, water can be safely released into surface waters or used various purposes.



Salicornia

- **Cost-effective operations and maintenance**
- **Efficient treatment of wastewater** from waste, agricultural runoff, and effluents from mining and industry
- **Use of local resources** to stand and manage the system
- **Low operational costs**
- **Assessment of surface water levels**
- **Contributes to environmental protection** by providing a habitat for plants and animals
- **Pleasing natural aesthetics**



Case Example: Institutional Building Constructed wetland at Indian Agriculture Research Institute, Pusa, New Delhi

Indian Agriculture Research Institute, Pusa, New Delhi	
Parameters	Details
Type of Building	Institution
Source of Wastewater	Drain coming from 2 colonies
Capacity of the system	2.2 MLD
Re-use	Agricultural Purpose
Capital Cost	Rs. 1.2 Crores
O&M Cost (per annum)	Rs. 1335 /-
Year of Implementation	2012



*The treatment plant comprises of 3-treatment cells (each of 80 meter by 40 meter), where **organic, nutrient and metal pollutant reductions (i.e. secondary and tertiary treatments)** take place; besides 2-sewage wells and 1-grit chamber, where **preliminary/ primary treatment** takes place.*

*Each treatment cell is stratified with a bed of gravels of varying sizes/ grades, onto which *Typha latifolia* – a hyper-accumulating emergent vegetation is planted.*

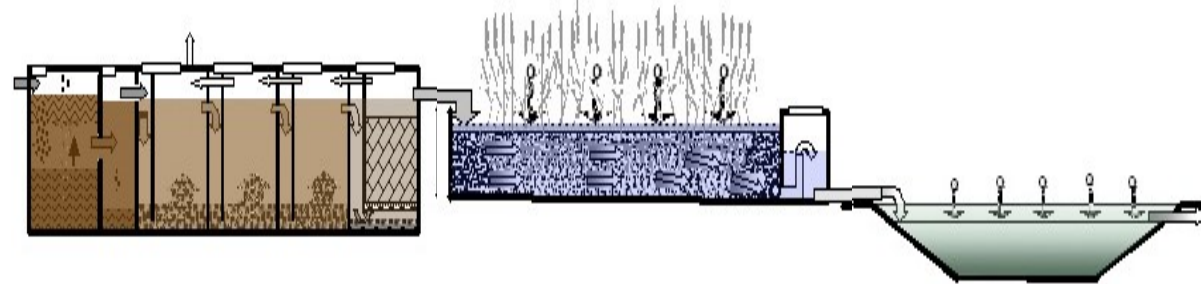
Decentralized Wastewater Treatment System (DWWTs)

विकेन्द्रिकरण दूषित जल उपचार संयंत्र

DWWTs is an easy and sustainable solution to treat wastewater with the combination of settler, anaerobic baffled reactor, anaerobic filter, planted gravel filter and polishing pond
विकेन्द्रिकरण दूषित जल उपचार संयंत्र एक आसान और सतत उपाय है दूषित जल के उपचार का, जो की सेटलर, एनारोबिक बैफल्ड रिएक्टर, एनारोबिक फ़िल्टर, बजरी filter और पोलिशिंग पोंड से बनकर तैयार होता है

Area Requirements Sq-m per Cum (As per Thumb Rules)

Settler	0.5
ABR + AF	1.0
PGF	4.0
Polishing Pond	1.2



**Primary + Secondary
(Settler + ABR + AF)**

Underground **anaerobic** process
Removal
25%-30% BOD removal – Settler
70%-90% BOD removal – Baffled reactor

**Removal of
suspended solids –
Inorganic material**

**Reduction of
Organic
contaminants**

**Secondary + Tertiary
(PGF)**

Above ground level **aerobic + anaerobic**
process
40%-60% BOD removal

**Nutrients removal
(Aeration through roots,
adsorption on filter
material)**

**Tertiary
(Polishing Pond)**

Odour & Pathogen

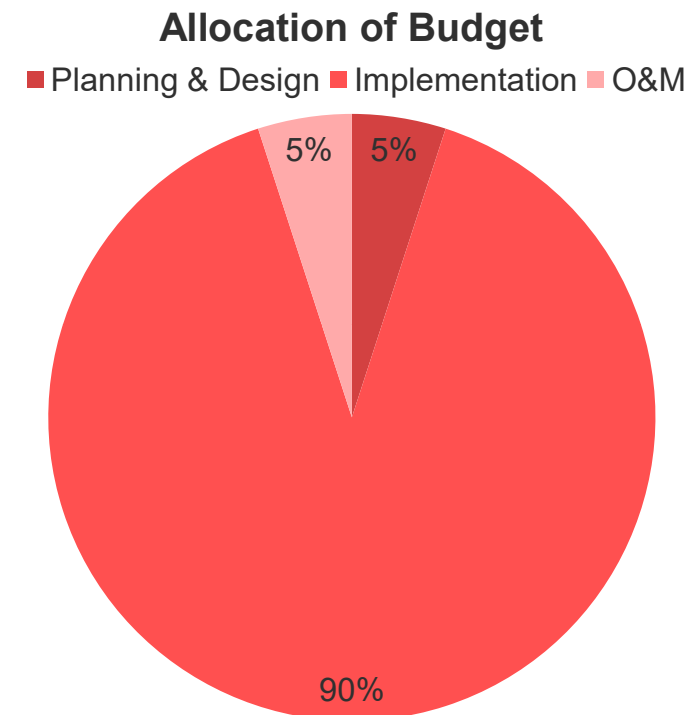


Costing of DWWTs Project

विकेन्द्रिकरण दूषित जल उपचार संयंत्र की
लागत

(As per Thumb Rules)

Capacity of DWWTs	CAPEX per Cum
1 – 8 KLD	1.2 – 1.5 Lac
10 – 25 KLD	70,000 – 80,000
Beyond 30 KLD	40,000 – 60,000



Operation & Maintenance Cost = 3 to 5% of CAPEX

Case example: Institutional Building Decentralized Wastewater Treatment System at CSE HQ

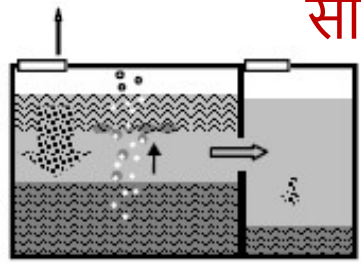
Centre for Science and Environment

Parameters	Details
Type of Building	Office Building
Source of Wastewater	Kitchen and Toilets
Capacity of the system	8KLD (Approx 150Users)
Re-use	For maintaining greenery
Capital Cost (2005)	Rs. 2,25,000/-
O&M Cost (per annum)	Rs. 30,000/-
Year of Implementation	2005

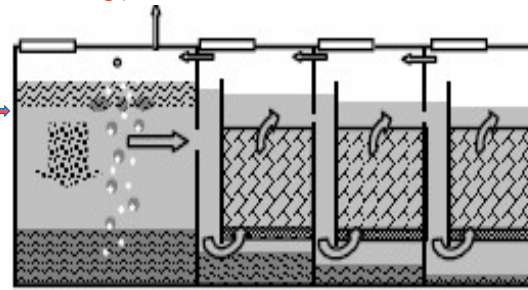


Process flow of DWWT system at CSE HQ

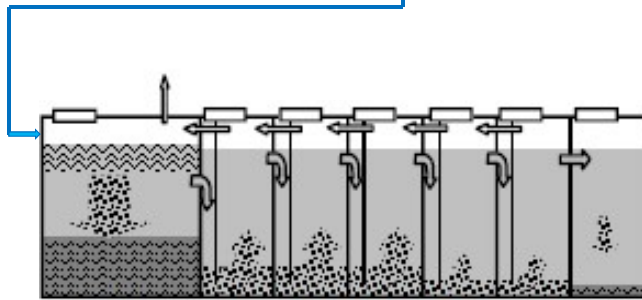
सीएसई में लगे विकेन्द्रिकरण दूषित जल उपचार संयंत्र की प्रक्रिया



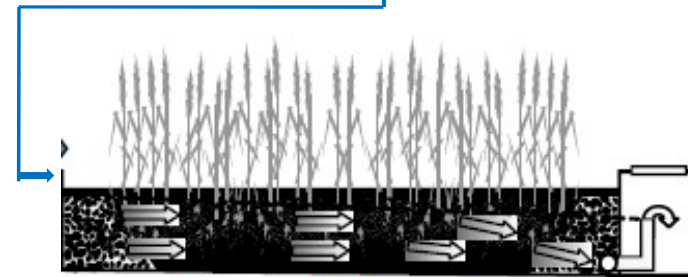
Septic tank / Settler



Anaerobic Filter

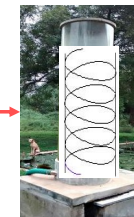


Anaerobic Baffled Reactor



Planted Gravel Filter

Ten chambers with two chambers of anaerobic filters



Vortex

DWWT at Institutional level

संस्थागत विकेन्द्रिकरण दूषित जल उपचार संयंत्र

Aravind Eye Hospital, Abhishekapakkam, Pondicherry, India

Parameters	Details
Year of Implementation	2003
Type of Building	Hospital and Residential Buildings together
System's area	2690 sq m
Capacity of the system	320 KLD
Re-use	Horticulture of 15 acres of area within the hospital premises
Capital Cost (2003)	INR 11.2 Million
O&M Cost (per annum)	INR 250,000-500,000



Settler and Anaerobic baffled reactors

Institutional Complex:

संस्थागत कॉम्पेक्स

Aravind Eye Hospital and Residential Buildings, Puducherry



Planted filter bed with
Canna indica

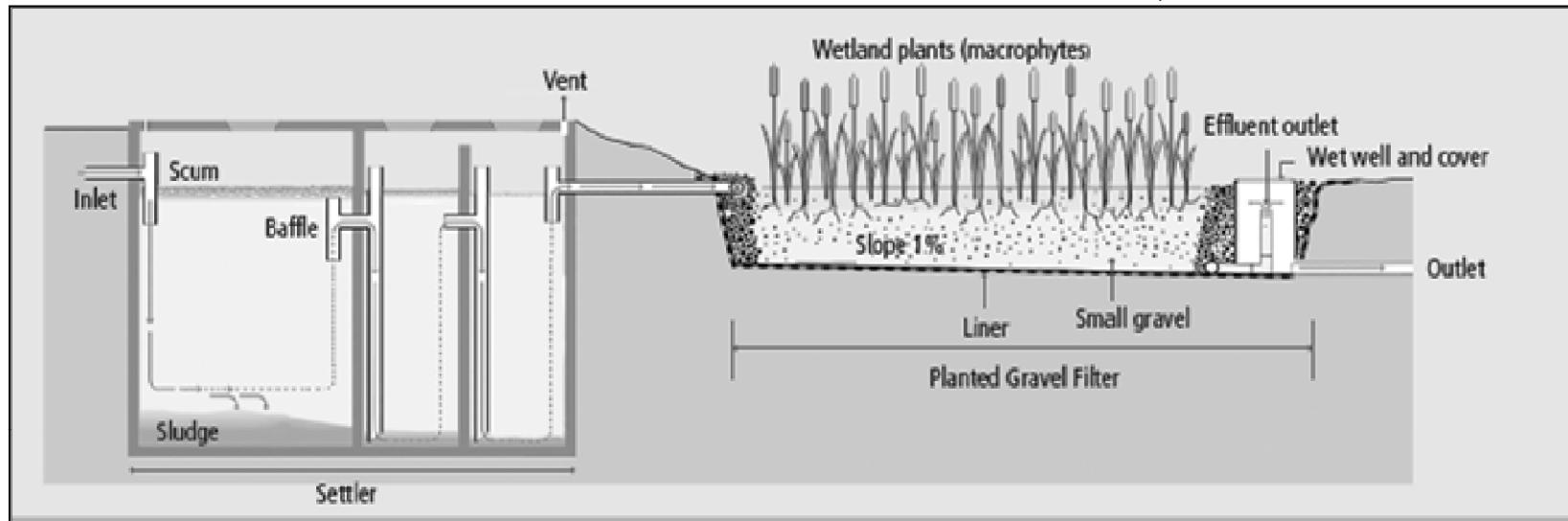


Polishing pond



Treated wastewater reuse for horticulture

Case Example: Public space DWWTs at Nehru Garden, Alwar



Implementing Agency: UIT, Alwar

Year of Implementation: 2016

Knowledge Partner and Design:
Centre for Science and Environment (CSE), New Delhi

Proposed use of treated water: Horticulture

Treatment Capacity: 100 KLD

Capital Cost: Rs. 32 Lakhs (2013)

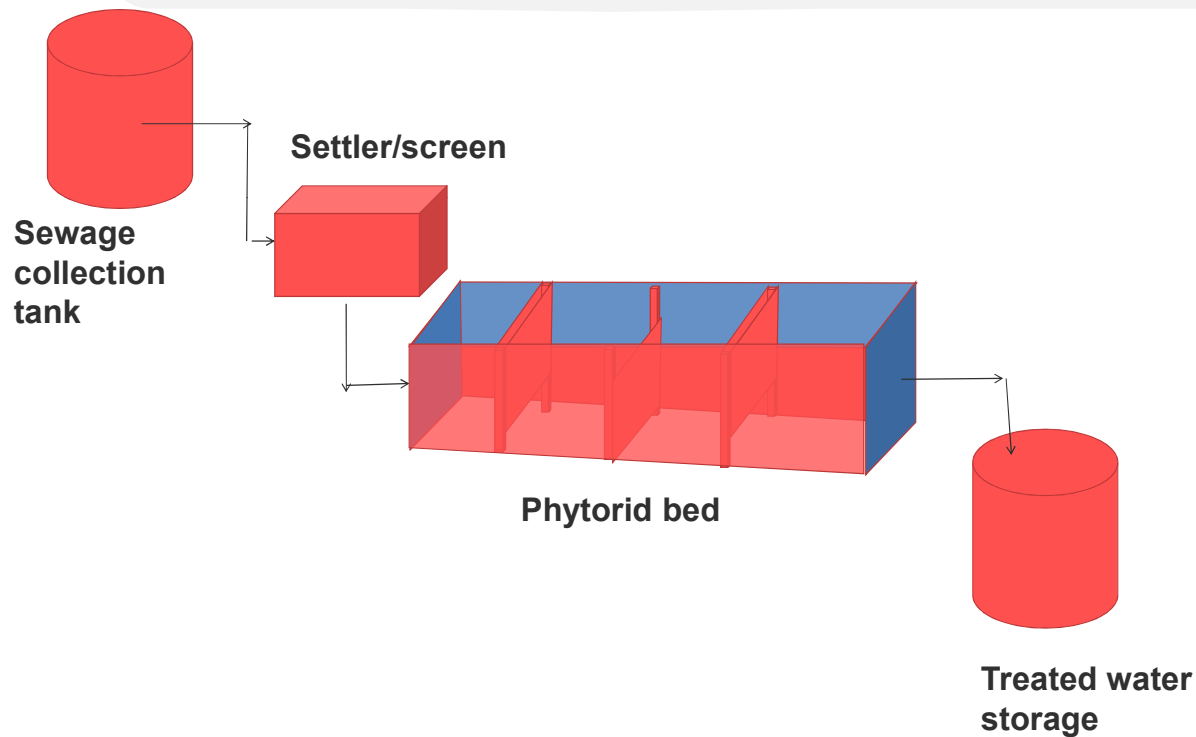
O&M Cost: Rs. 1.1 -1.5 Lakhs/annum

Total Area: 730 m²

Phytorid Wastewater Treatment System

फायटोरिड दूषित जल उपचार संयंत्र

Phytorid is a sub-surface flow type treatment system, it treats wastewater with the help of porous media such as crushed bricks, gravels and wetland plants. The system is divided broadly into the three zones viz. inlet zone, treatment zone and outlet zone.



Treated water can be utilized in irrigation, fountains etc.

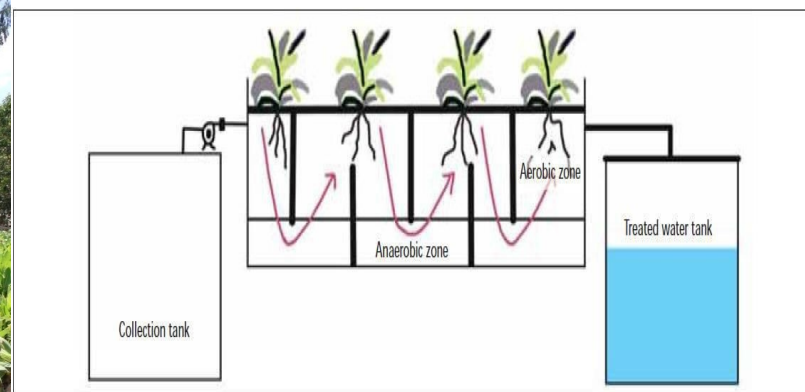
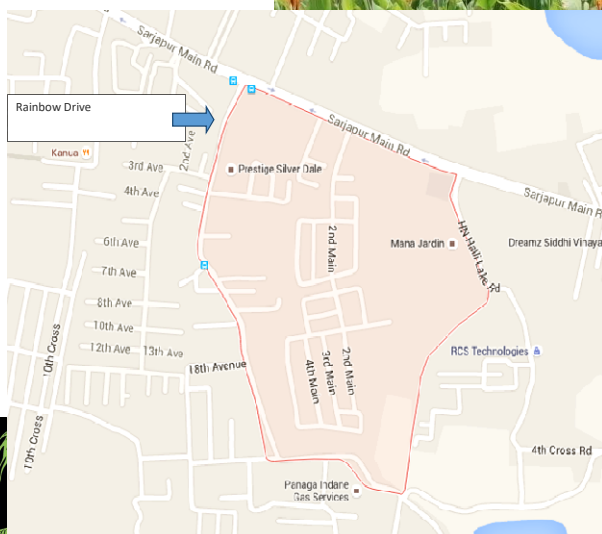
Processes

- Sedimentation
- Bacterial action
- Filtration
- Adsorption
- Precipitation
- Decomposition
- Nutrient uptake
- Vegetation system

Case example: Housing Society

Phytorid Technology based treatment plant at Rainbow Drive Society, Bangalore

Rainbow Drive is a **36 acre neighborhood** with **430 plots** located in south east Bangalore.



Parameters	Details
Year of Implementation	2014
Type of Building	Community level
Capacity of the system	250 KLD
Re-use	For maintaining green landscapes
Capital Cost	INR. 55 Lakhs
O&M Cost (per annum)	INR. 10,000

Soil Bio-technology (SBT)

सोइल बायोटेक्नोलॉजी (एस बी टी)

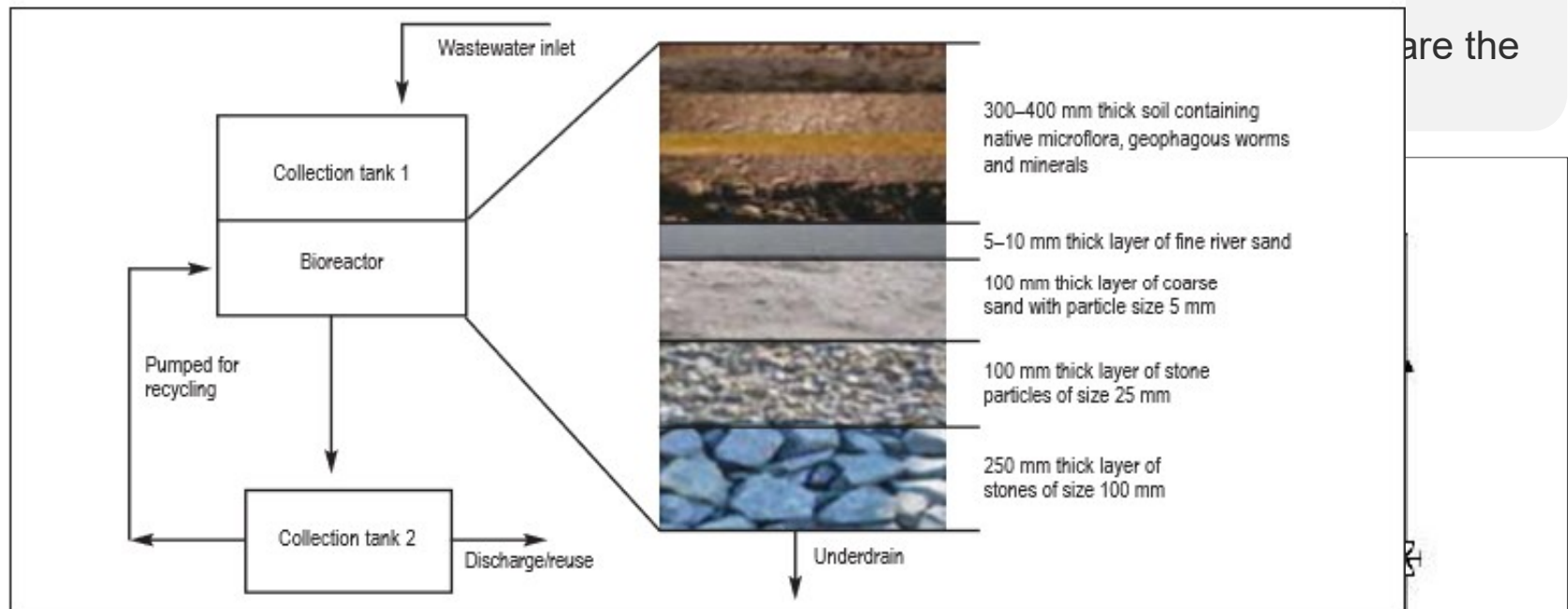
Soil Bio-technology is a terrestrial system for wastewater treatment with the combination of physical and biochemical processes. It is based on the principle of trickling filter.

Suitable r

are the

Salient Features:

- The process can be run on batch or continuous mode.
 - The overall time of operation is 6-7 hours per day.
 - No sludge production
- Mechanical aeration is not required.



Source: HS Shankar et al 'Soil conditioning products from organic waste', Patent No: 7604742B2. October 2009. US

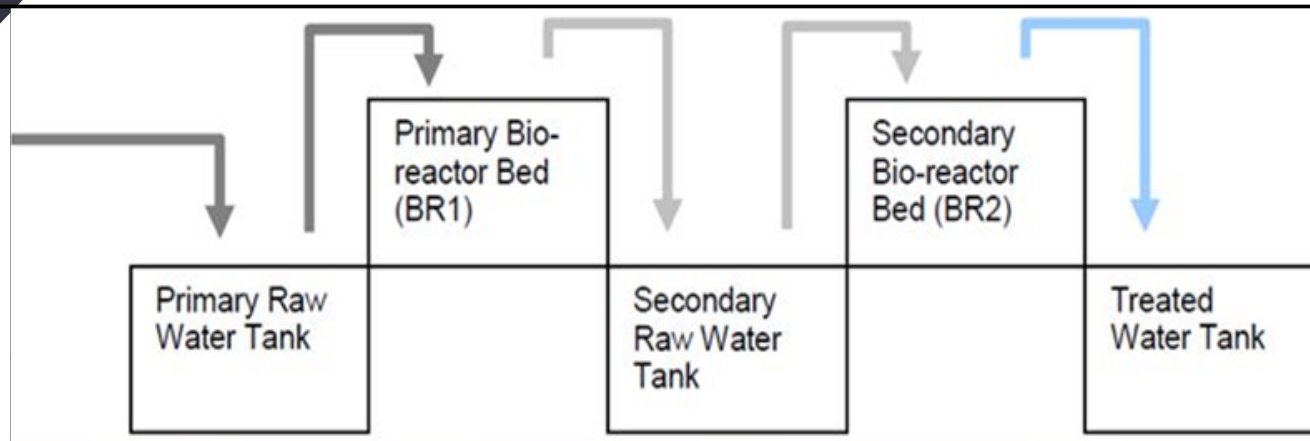


Trickling of wastewater through u-PVC pipes on the bioreactor



Case Example: Public Place

Soil Bio-Technology at Lodhi Gardens, New Delhi सोइल बायोटेक्नोलॉजी (एस बी टी), लोधी गार्डन, नयी दिल्ली



The organic content of the sewage is removed as it passes through bioreactor bed. The bioreactor bed can be customized depending upon local conditions.

The treatment within the bed takes place via adsorption by the layers of soil followed by biological aerobic degradation. This creates acidic conditions which is regulated by the chemical weathering of mineral additives that are added in the bioreactor bed. In addition, photosynthesis of natural flora serves as a bio-indicator of the micro-habitat. Rates of mineral weathering and photosynthesis are slow and a majority of the treatment can be attributed to the sedimentation, infiltration and bio-degradation processes.

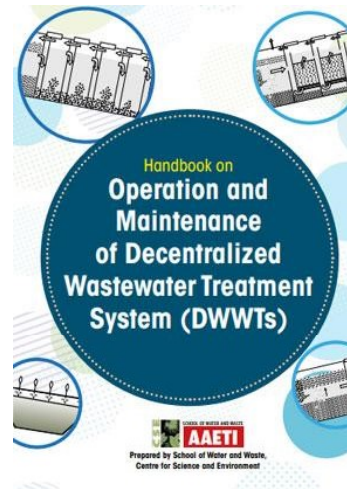
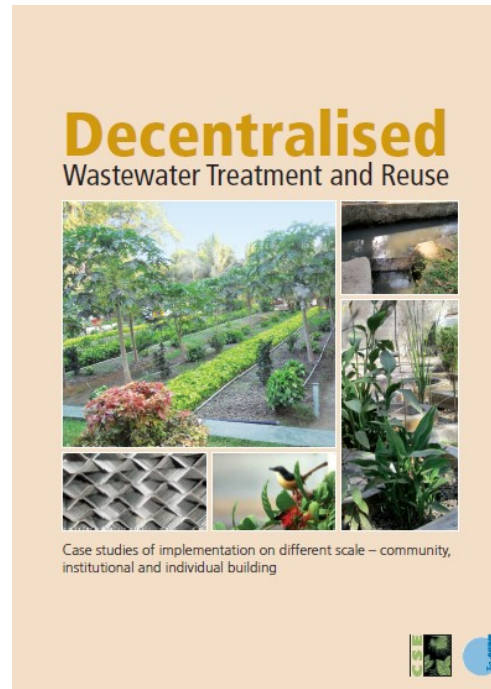
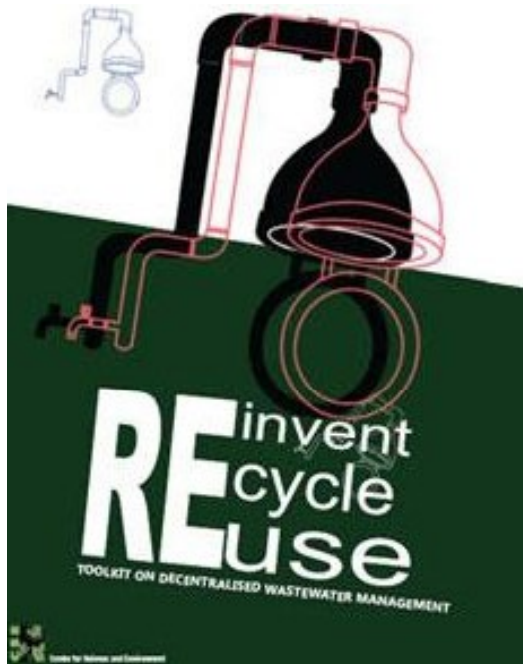
PPP contract between NDMC (owners of the gardens) and Vision Earth (technology providers) is based on the **Hybrid Annuity Model**. Under this contract, the payments made to Vision Earth are subject to performance of the treatment system.

Land Use:	Capac	Capital	Cost:
Recreation	ity:	₹2 Crore	
al (90	500		
acres)	KLD		
	Year:	O&M	Cost:
	2017	₹50,000 p.a.	

Lucknow Airport



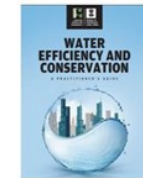
For more details visit <https://www.cseindia.org/page/water-and-wastewater-management>



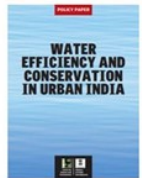
Water Sensitive Urban Design and Planning



Green Infrastructure



Water Efficiency and Conservation - A Practitioner's Guide



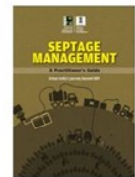
Policy Paper: Water Efficiency and Conservation in Urban India



Urban Water Sustainability: A Template



Mainstreaming Energy Efficiency in Urban Water and Wastewater Management in the Wake of Climate Change



Septage Management - A Practitioner's Guide

THANK YOU

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