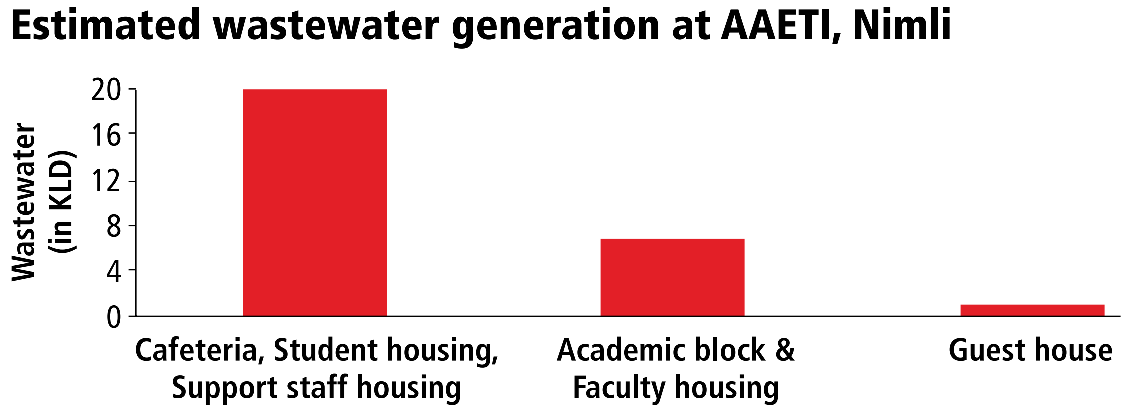
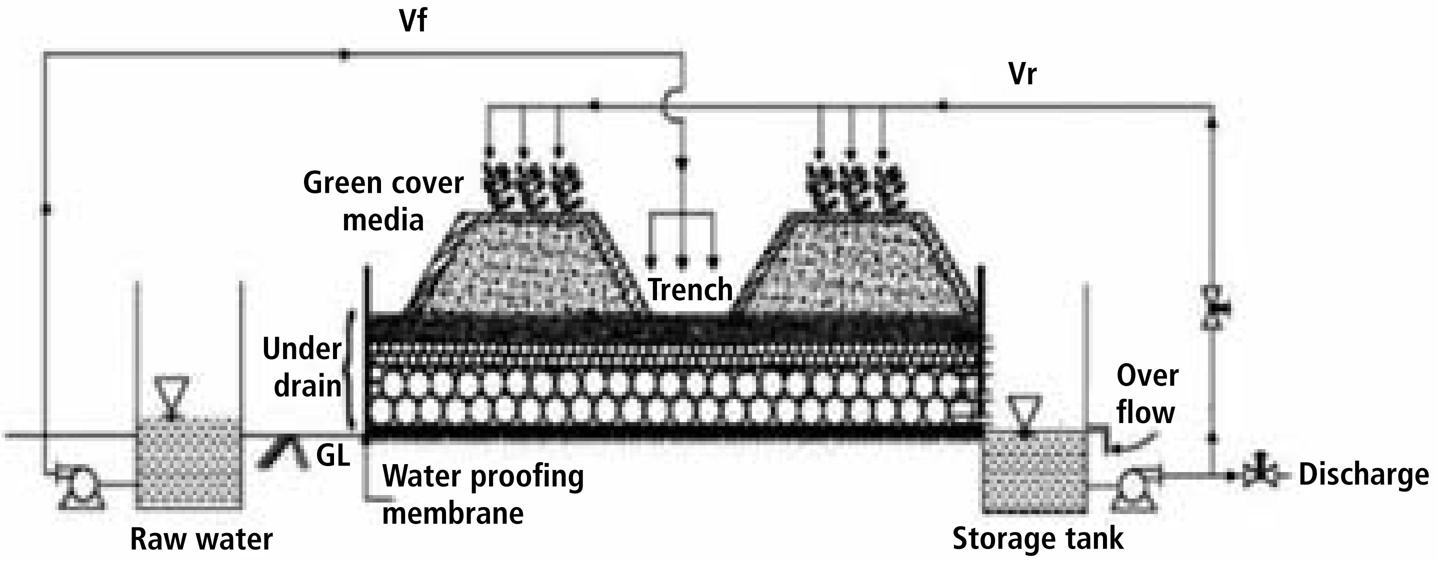
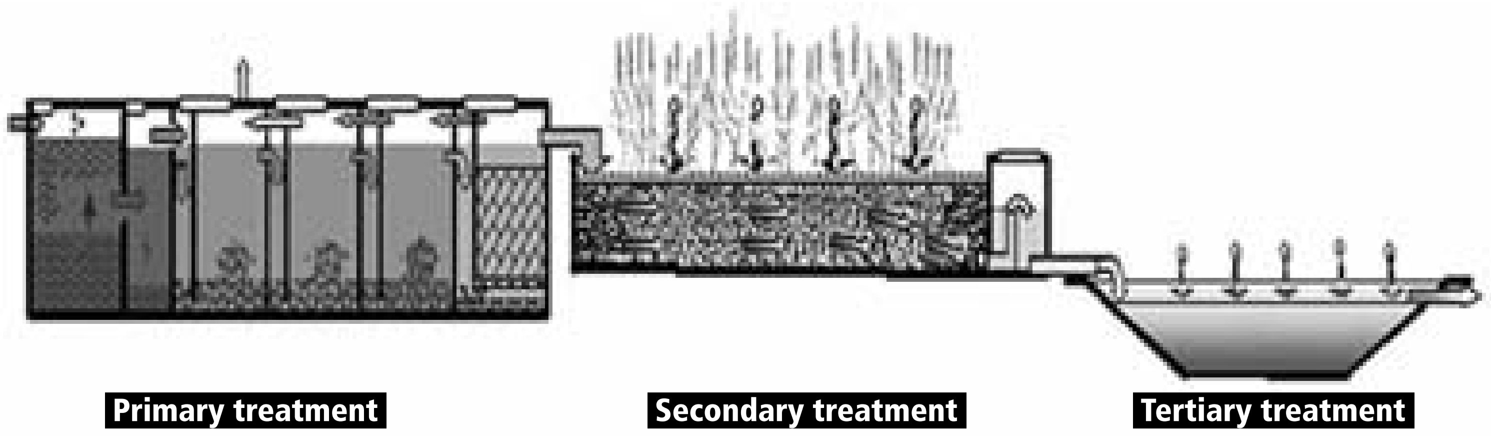
Wastewater management

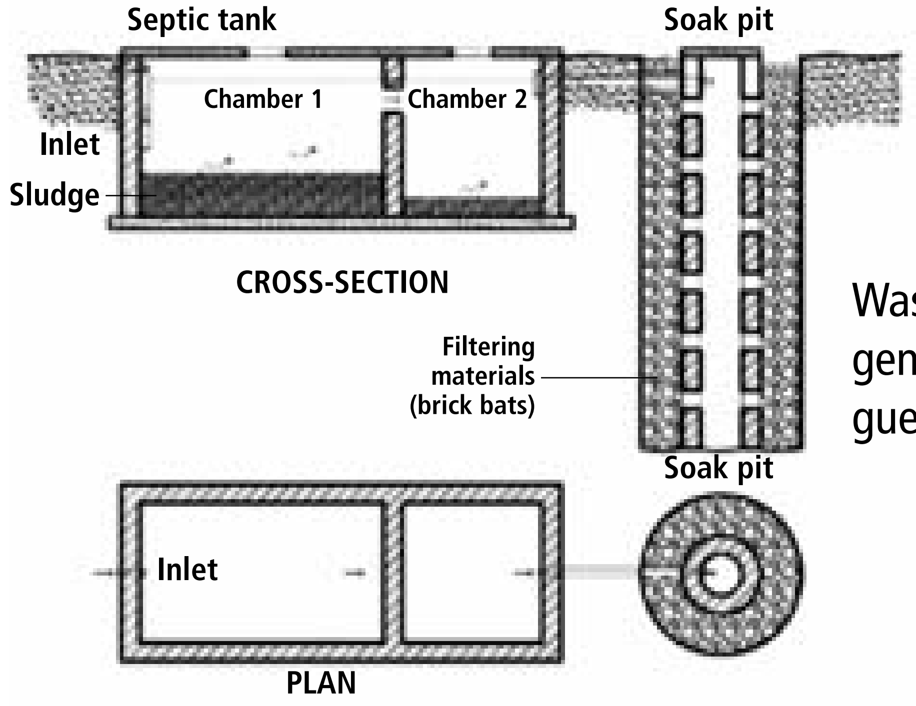




Soil Bio Technology (SBT) system to treat waste-water generated from Academic block and Faculty housing (7KLD) - Reuse for horticulture purposes.



DWWT system to treat waste-water generated from Cafeteria, Student Housing, Support staff housing (20KLD) - Reuse for flushing purposes in Student housing and Academic block, excess for horticulture



Wastewater generated in the guest house 1 KLD

The cost of an RHW system will depend on a number of factors:

1. Catchments: The cost on storage or recharge structures will depend on type of catchments and area, which will determine the amount of water harvested and therefore the size of the structures.

2. Drainage pattern: The cost on the conveyance systems will depend on the flow direction, spreading of rainwater pipes and flow of stormwater drains.

3. Retrofitting/new construction: Retrofitting on existing buildings will cost more than new construction.

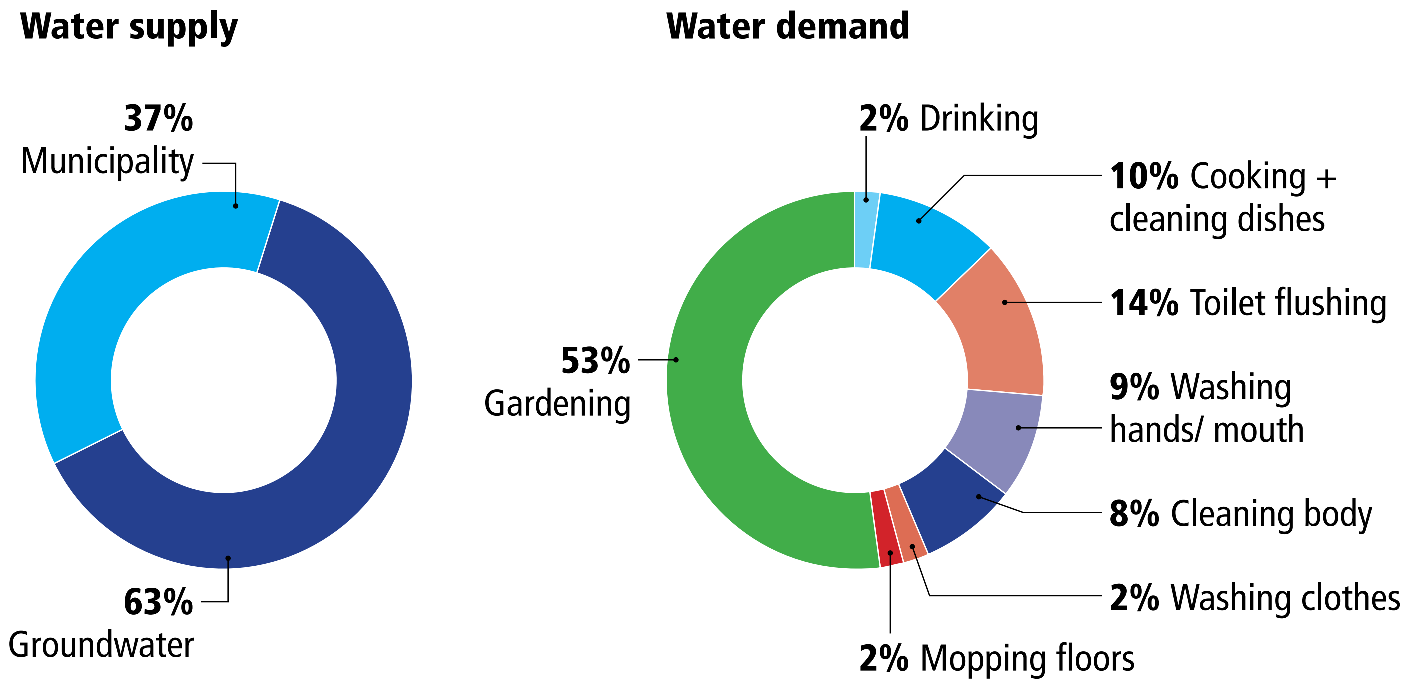
4. Geology, hydro-geology and meteorological parameters: Recharge structures in hard rock terrain will cost more and areas of high intensity rainfall will require larger storage.

5. Purpose of harvesting: Treatment systems will increase cost and therefore the use of the rainwater will determine cost.

6. Availability of unused tanks: Availability of unused or dry/abandoned tube wells/open wells will reduce cost.

7. Material used: The cost of the system will also depend on the material used.

Water Audit: Janki Devi



In order to monitor the quantity of water being used, the following audit should be carried out:

Gather information on where you are getting your water from (municipal, groundwater, tanker)

- Find out what is your total water requirement.
- How much of this demand are you getting from your supplies.
- How do you use your water (drinking, cooking, bathing, washing utensils & clothes, toilet requirements, gardening, other miscellaneous such as car wash, courtyard wash)
- Identify all possible avenues for reduction of use.
- Identify priority or most effective use for harvested rainwater

Storage of rainwater

M M Sharma of Hastinapur locality, Hyderabad

He began by tapping rainwater on his roof, storing it in an underground sump. His reliance on the borewell decreased and stopped entirely in 2003.The municipal water supply is now used only for gardening and flushing toilets.

Standing in his private water reservoir—the quality doesn't seem to need any certification—is a man who doesn't have to wake up at odd hours when the municipality supplies water. He doesn't need to deepen his borewell every year.

Maintenance: Sunlight needs to be blocked to keep out algae. Sharma's tank does that. This prevents breeding of mosquitoes. The roof is always kept clean. Before the monsoon, the tank is emptied once for cleaning and repairs. Filters are cleaned once a year. A stairway from the storeroom goes down to the tank.

Calculating size of tank

A. Based on availability

Rainfall = 500 mm

Rooftop area: 100 sq m

Per capita consumption: 100 lpcd

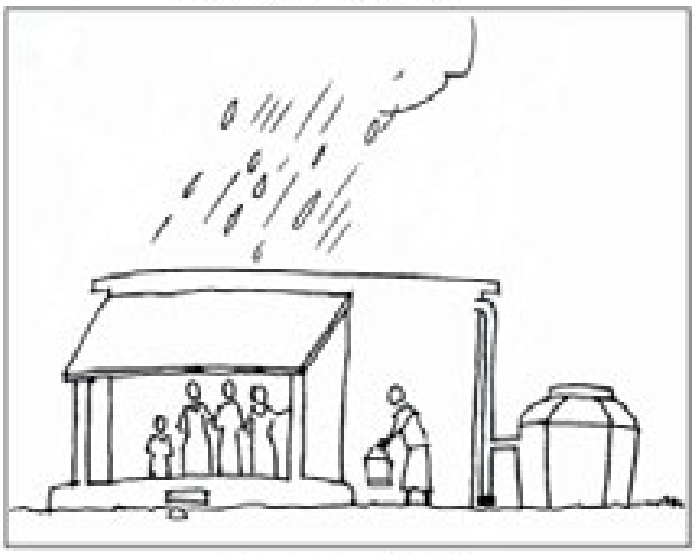
Water to store for dry days: 2 x 100 x 100 = 20,000 litres

Available rainwater: 100 x 500 x 0.8 = 40,000 litres

Availability more than demand

Sizing of tank based on demand: 20,000 litres

B. Based on demand



Rainfall = 250 mm

Rooftop area: 100 sq m

Per capita consumption: 60 lpcd

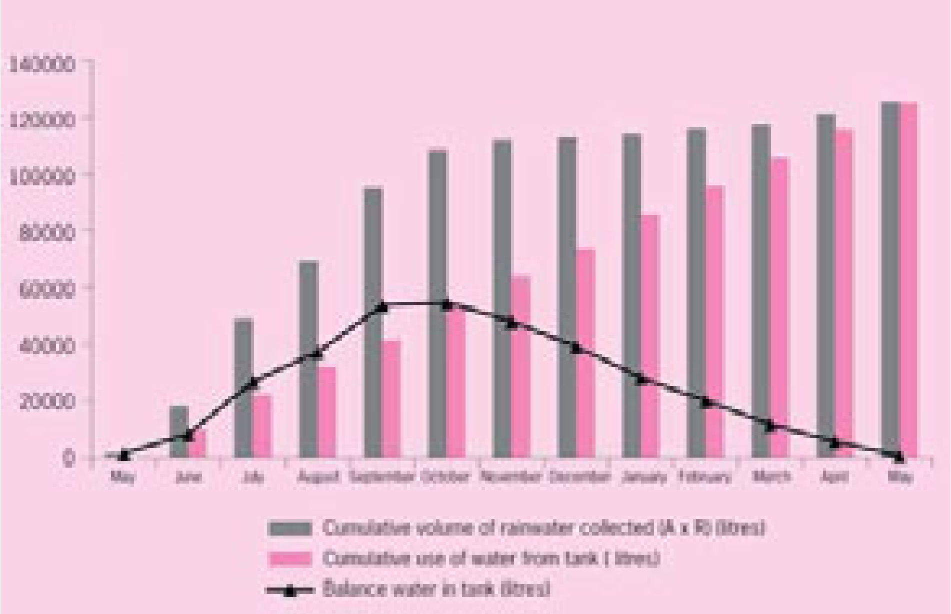
Water to store for dry days: 5 x 60 x 100 = 30,000 litres

Available rainwater: 100 x 250 x 0.8 = 20,000 litres

Demand more than availability

Sizing of tank based on availability: 20,000 litres

Monthly rainwater collected, monthly use of water



System Details

Total Rooftop Area = 160 sq.m

Rainwater potential = 804 X 160 X 0.8 = 102,910 litres

Volume of Storage Tank = 90,000 litres

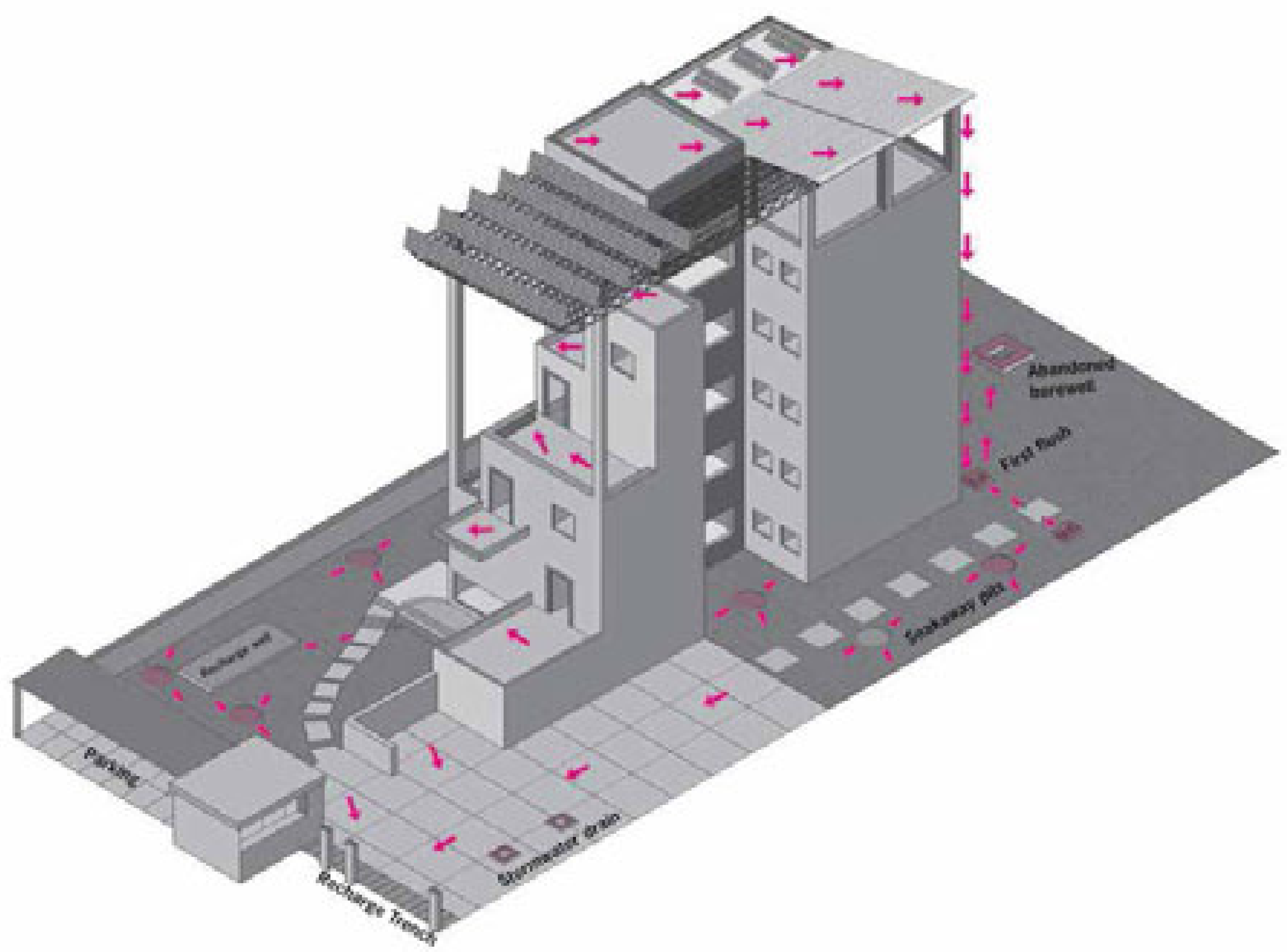
Volume of Filter Tank = 25,000 litres

Mesh size of the three filter chambers

1) In The First Filter Chamber = 2.5 cm X 2.5 cm
2) In The Second Chamber = 1 cm X 1 cm
3) In The Third Chamber = 2 mm X 2 mm

Cost = ₹ 41,000 in the year 1995

CSE's rainwater harvesting system



Dimensions of the recharge pits [length (l) x breadth (b) x depth (d)]: 0.6 m x 0.6 m x 0.5 m
Unpaved area catchment: 615 sq m

Dimensions of the recharge trench (l x b x d): 6.2 m x 0.7 m x 0.5 m = 2.17 cu m
Dimensions of recharge pit within trench (l x b x d): 0.3 m x 0.3 m x 0.3 m = 0.9 cu m
Total trench volume: 3.07 cu m
Unpaved catchment area: 133 sq m
Rainfall intensity used for design: 90 mm/hour or 22.5 mm/15 minutes
Rainwater harvesting potential in 15 minutes: 33 x 0.023 x 0.5 = 1.53 cu m
Space for filter materials: 1.53 cu m
Volume of trench should be: 1.53 + 1.53 = 3.06 cu m
Actual trench volume: 3.07 cu m

Dimensions of the recharge well (l x b x d): 2.8 m x 1.75 m x 3.0 m
Filter materials are filled up to a depth of 75 cm.
Volume of the recharge well sump = 11.03 cum
Rooftop area for the recharge well: (Floors 1-5) = 35 + 25 + 23 + 9 + 20 = 112 sq m
Rainwater harvesting potential in 15 minutes = 112 x 0.023 x 0.8 = 2.06 cu m

THE SYSTEM

A simple system was designed. It comprised of the following:

- Recharge pits with bores to reach water to the first permeable layer of soils around the building in the unpaved areas.
- Recharge trench at the front of the building to arrest water from flowing away.
- Recharge well (coverted from an old storage tank) to recharge water from the roof areas.
- Using a defunct borewell to recharge water from roof areas.

IMPACT

This institution barely gets any municipal water supply. Therefore, it has to depend on borewells. The demand for water has been steadily rising as the number of persons have increased by 20 per cent. Nevertheless, the post-monsoon groundwater level has been maintained around 65 metres below ground level (m bgl).

Rainwater maintenance

Sources of contamination and prevention methods

Part of RWH system	Contaminants & source	Prevention methods
Roof	• Dust/air pollutants from surrounding area, • Bacteria from bird/animal droppings, • Organic debris such as leaves or other plant materials from overhanging trees, • Toxic chemicals if roof is treated, painted or is made of aged asbestos	• Regular cleaning of catchments, • Trim overhanging branches, • Leaf mesh, • First flush, • Avoid painted/ treated roofs, • Avoid harvesting water in areas close to places where there may be continuous presence of air pollutants such as from cement plants and other industries
Conveyance pipes and gutters	• Toxic chemicals, when conveyance systems are made of materials that can leach toxic substances, • Accumulated dust or debris	• Ensure conveyance pipes are made of non-toxic substances, • Regular cleaning of pipes and gutters, • Fixing gutters and pipes them appropriately to prevent water stagnating
Storage tanks	• Mosquito larvae where tank water is not properly protected to prevent entry of mosquitoes, • Dust or debris, silt, organic debris, • Growth of bacteria, algae	• Proper sealing of covers, regular cleaning of tanks, • Filter systems at entry points into tanks, • Use non-toxic materials such as plastic, metal, cement, brick masonry, ferrocement, • Prevent sunlight from entering tank
Underground storage systems	• Dust, silt, bacteria, organic debris, chemical contamination, sewage	• Proper sealing of covers, • Regular cleaning of tanks, • Filter systems at entry points into tanks, • Avoid water from areas where agricultural chemicals are used
Recharge systems	• Dust, industrial air pollutants, silt, bacteria, organic debris, chemical contamination, sewage resulting from nonmaintenance of recharge tanks and filter media	• Avoid water from catchments in industrial areas, • Regular cleaning of desiltation chamber and recharge tanks, • Annual maintenance of filter media, • Site tanks far away from sewage pipes/soak-pits, • Regular repair of storage tank walls

Quality guidelines from harvested rainwater

Parameter	Guideline value
Faecal coli form of E. coli	Not detectable in a 100 ml sample
Aluminium	0.2 mg/l (level likely to result in consumer complaints)
Cadmium	0.003 mg/l
Copper	2 mg/l
Chloride	250 mg/l (level likely to result in consumer complaints)
Fluoride	1.5 mg/l
Iron	0.3 mg/l (level likely to result in consumer complaints)
Lead	0.01 mg/l
Sodium	200 mg/l (level likely to result in consumer complaints)
Sulphate	250 mg/l (level likely to result in consumer complaints)
Turbidity	5 NTU (level likely to result in consumer complaints)
Total dissolved solids	1,000 mg/l (level likely to result in consumer complaints)
Zinc	3 mg/l (level likely to result in consumer complaints)

Note: These are guidelines of the World Health Organization, 1996 Source: Luke Mosley 2005, 'Water quality of rainwater harvesting systems', SOPAC Miscellaneous Report, February, p 16

When maintenance takes a back-seat

Type of maintenance fault	Result
Lack of regular cleaning of filling material in percolation pits/tanks	Stagnation of water in percolation pits
Obstruction of roof and gutter with garbage in tiled houses	Stagnation of water on roofs
Cracks on sidewalls of percolation pits	Entry of ovipositing female mosquitoes
Blockage of conveyance pipes by garbage	Stagnation of water on roofs
Obstruction of PVC pipes linked to wells with debris	Stagnation of water
Damages to conveyance structure	Leakage of rainwater into street drains or seepage of sullage water into the system
Open plastic/iron drums used for harvesting rainwater	Promoted mosquito proliferation
No conveyance pipe in system or percolation pits	System does not work, stagnation of water

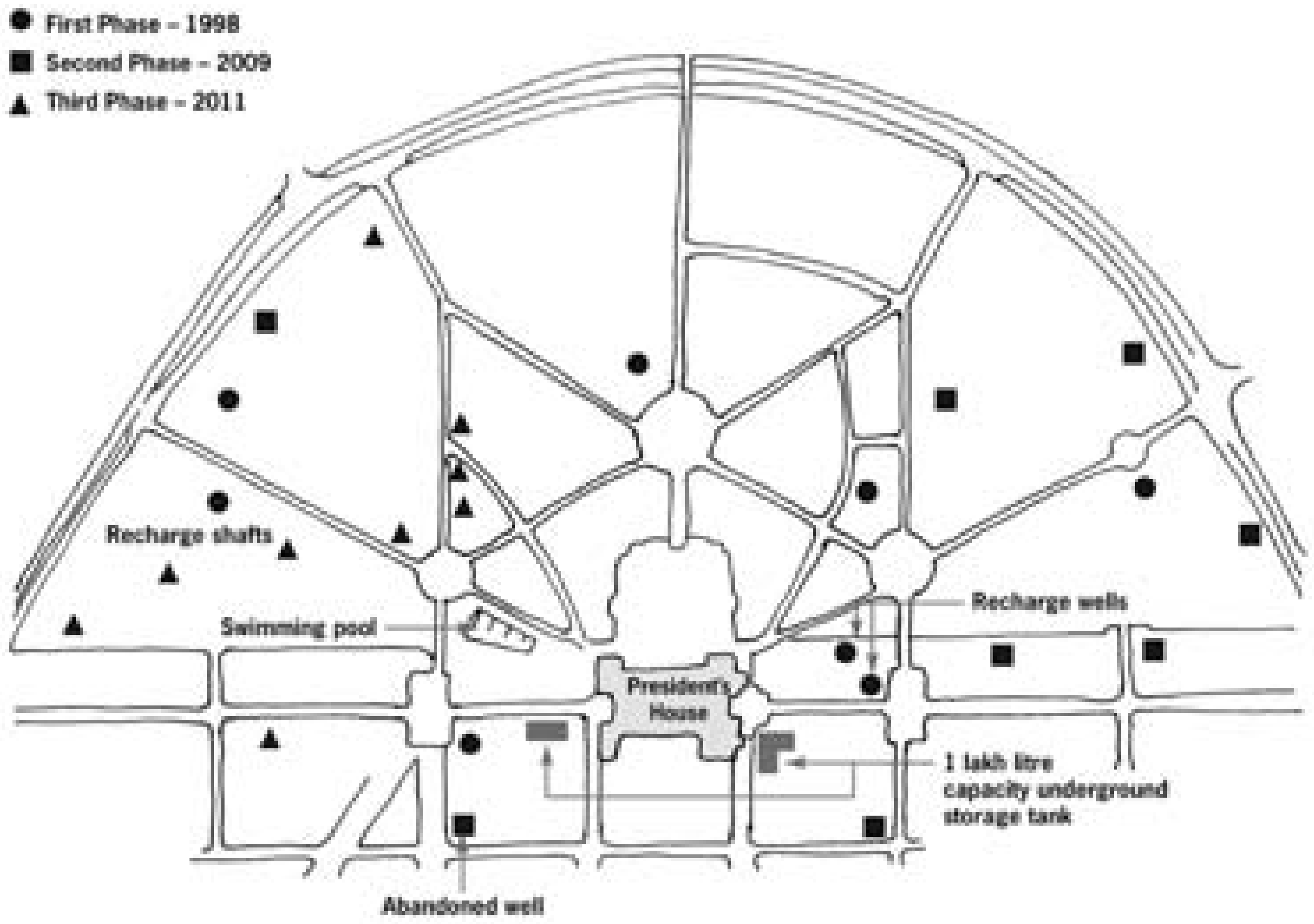
Source: Centre for Science and Environment, New Delhi

Avoid diseases, use rainwater

In recent years, fluoride and arsenic contamination of groundwater has become widespread in India. It results in fluorosis, (which affects the dental, skeletal and neurological systems) and arsenicosis (cancers of the skin, bladder, lung) and aggravates diabetes and kidney malfunctions. Treatment is expensive and mostly irreversible.

While there are efforts to develop filters to separate arsenic and fluorides out of water these are expensive and need to be handled carefully. A simple method to avoid contamination would be to harvest rainwater and use it for drinking and cooking purposes. This method is being taken up on a large scale in affected areas in India and Bangladesh.

Rashtrapati Bhawan
New Delhi



System details

Total catchment area: 1,456,868 sq m

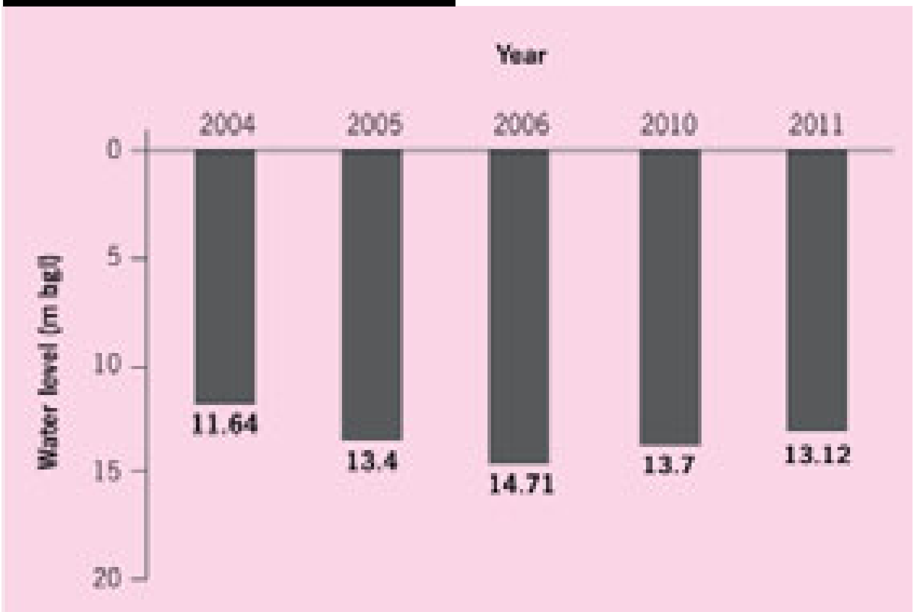
Recharge well (open wells): 3

Underground sumps: 2 (100,000 litres each)

Recharge wells: 22

Designed and implemented by: ***Centre for Science and Environment***, Central Ground Water Board, and Central Public Works Department, New Delhi

Groundwater decline arrested



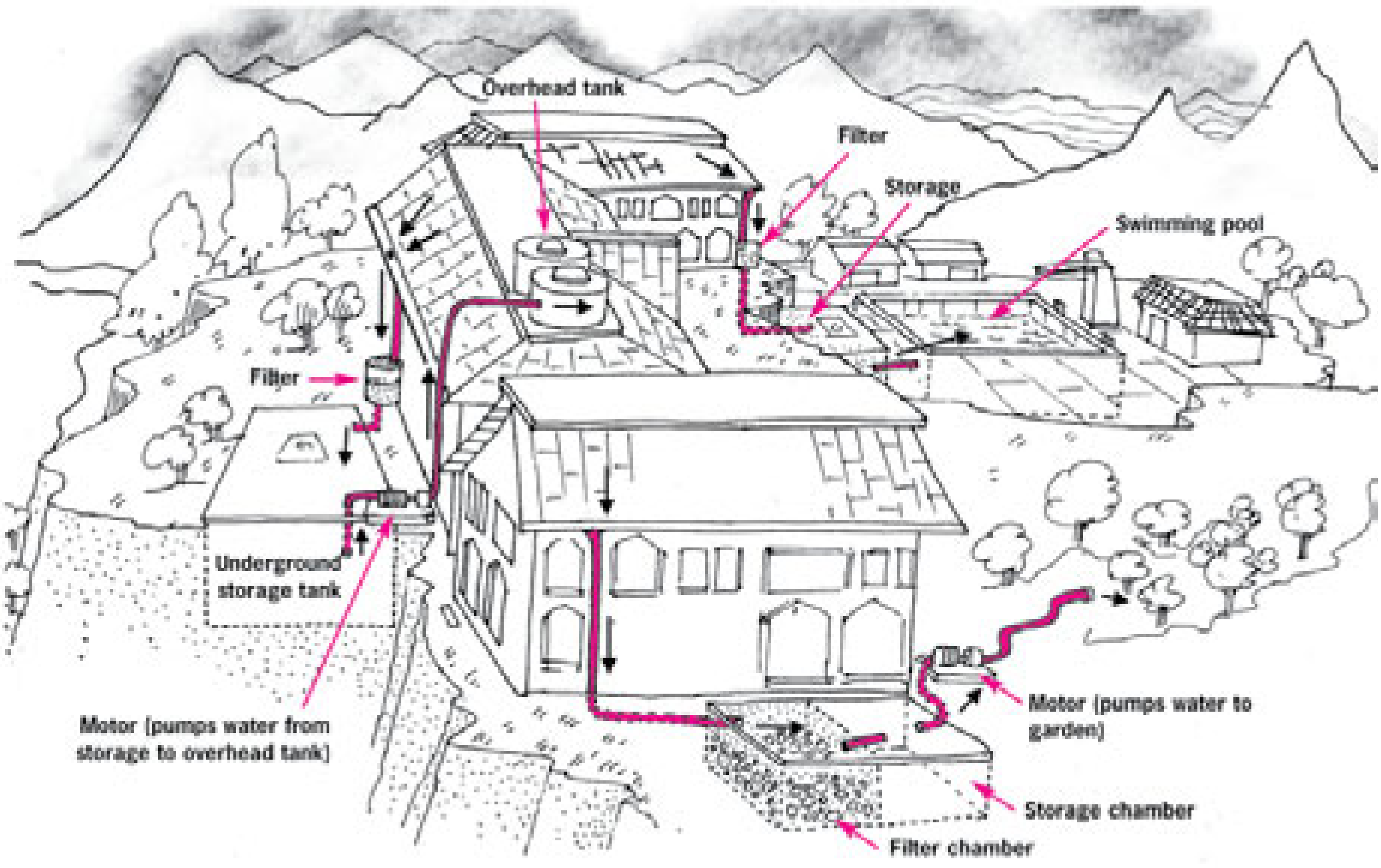
Note: m bgl = metres below ground level; Source: Central Public Works Department

Groundwater recharge rate can be calculated using water level monitoring/piezometer or infiltration test. It is recommended that the monitoring be done monthly especially pre and post-monsoon.

IMPACT

The President's Estate monitors the water level regularly through a piezometer at different locations. Annual data recorded shows that from 2003 onwards, when the monitoring started, the Estate has managed to arrest groundwater decline. The pre-monsoon reading of groundwater level in June 2003 was 12.06 metres below ground level (m bgl) while the post-monsoon reading in September 2011 was 13.12 m bgl

Bishop Cotton School, Shimla



System details

Total rooftop area: 1,867.30 sq m

Total storage capacity: 555,000 litres

Filtration drums: 1.5 ft to 2 ft dia

Filtration tanks: 1.5 ft x 1.5 ft x 1.5 ft

Filter media layers: stone: 0.4-0.15 cm; grits: 0.1-0.15 cm; chips: 0.15 cm; sand: 0.15 cm

Total cost (2000-2002): ₹ 16.65 lakh

Designed and implemented by: Bishop Cotton School

Rainwater harvesting filter

Underground storage tank

Catchment areas in the school

Name of the building	Roof area (sq m)	Capacity of the tank (litres)
Main dormitory and dining hall	301.50	185,000
Activity Centre	237.00	60,000
Remove Building (Lewis Block)	928.80	60,000
Headmaster's Lodge	400.00	250,000
Total	1,867.30	555,000

Source: Bishop Cotton School, Shimla

The stored water is used for laundry, flushing and gardening, thereby saving municipal supply for drinking and cooking purposes

IMPACT

The stored water is used for laundry, flushing and gardening, thereby saving municipal supply for drinking and cooking purposes.

Cities – Waste management

71-CITY SURVEY: AREA COVERED BY CLOSED DRAINS SHOWS REAL STATE OF SEWAGE COLLECTION

% of area covered	
0-10	Cuttack, Guwahati, Jabalpur, Jammu, Ranchi, Thane, Aizawl, Bathinda, Bhilwara, Siliguri, Srikakulam
10-30	Agra, Alwar, Aurangabad, Indore, Mathura, Meerut, Puducherry, Thiruvananthapuram, Dehradun, Dewas, Hubli-Dharwad, Jhansi, Kozhikode, Lucknow, Solapur, Tumkur, Udaipur, Ujjain, Dhanbad
30-50	Allahabad, Bengaluru, Bhopal, Delhi, Lucknow, Patna, Srinagar, Amritsar, Bhubaneswar, Jodhpur, Mumbai
50-70	Faridabad[2], Hyderabad, Jaipur[1], Kanpur, Kolkata, Nagpur, Gwalior, Mussoorie, Nainital, Rajkot, Vadodara, Yamunanagar
> 70	Chennai, Pune, Surat, Gurgaon[2]

[1]Claims 80% coverage in CSE survey, 65% in City Development Plan for JNNURM; [2]Faridabad and Gurgaon: only old-city within municipal limit included
Source: Anon 2011, *71-City Water-Excreta Survey, 2005-06*, Centre for Science and Environment, New Delhi

<10

Guwahati, Jabalpur, Jammu, Ranchi, Thane, Aizawl, Bathinda, Bhilwara, Jammu, Jabalpur, Siliguri, Srikakulam

Cities do not have drains

New growth cities are growing without drains

Backlog and front-log impossible to fix

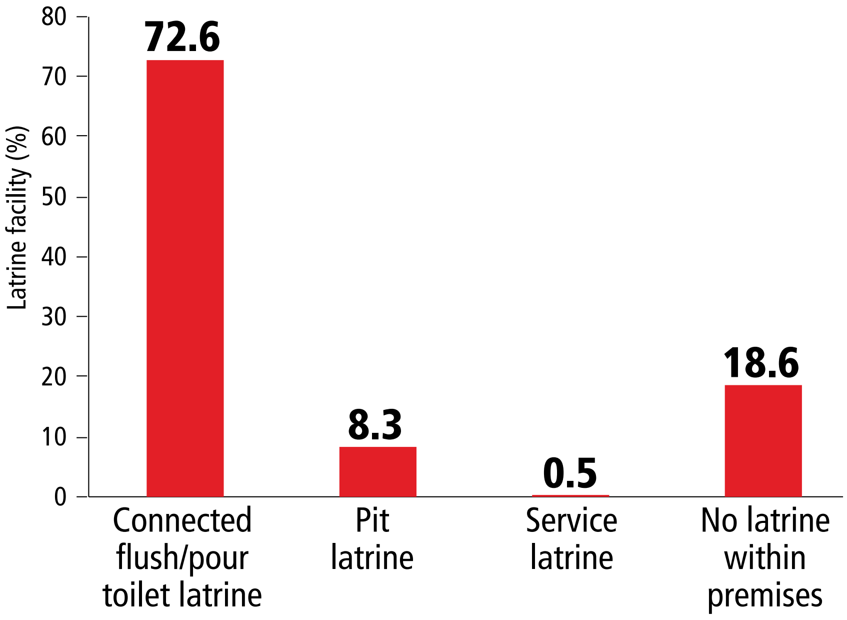
As cities fix one drain, another goes under

Bulk of the toilets connected to septic tanks

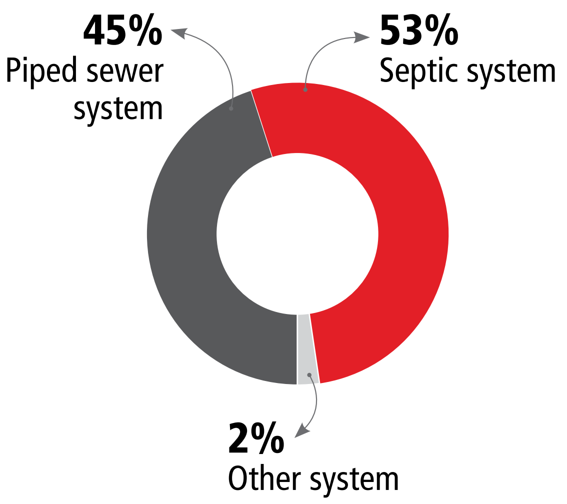
Census 2011	
Flush/pour toilet latrine connected to	72.6
a. Piped sewer system	32.7
b. Septic System	38.2
c. Other System	1.7
Pit Latrine	8.3
a. With slab/ventilated improved pit	6.4
b. Without slab/open	0.7
c. Night soil disposed into open drain	1.2
Service latrine	0.5
a. Night soil removed by human	0.3
b. Night soil serviced by animals	0.2
No Latrine within premises	18.6
a. Public latrine	6.0
b. Open	12.6

Source: Census of India 2011, Houses, Household Amenities and Assets: Latrine Facility

Latrine facilities in India



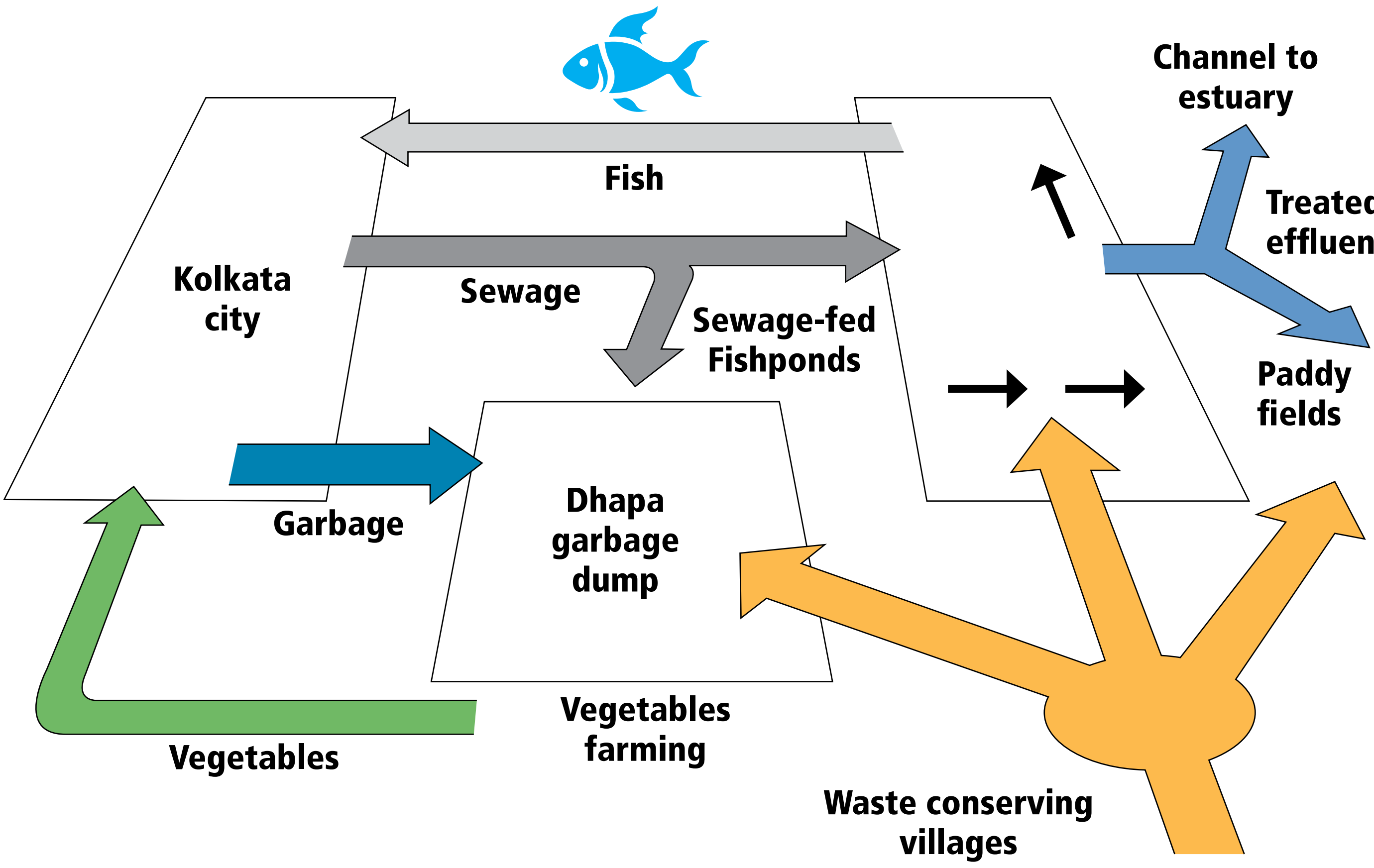
Connection of flush/pour latrine to different system



Source: Census of India 2011

Technologies for decentralised waste management

Kolkata has a unique natural sewage treatment system – the East Kolkata wetlands, ponds and marshes. The wetlands receives and effectively treat some 810 million litre daily (MLD) of city sewage. The wetlands purify the water through oxidation and natural aeration, in fish ponds and channels covering some 2,000 km. The sewage flows in a series of ponds where the sludge settles down and oxidation occurs as the sewage is exposed to sunlight.



Augmenting water not enough; need to improve efficiency: fixtures

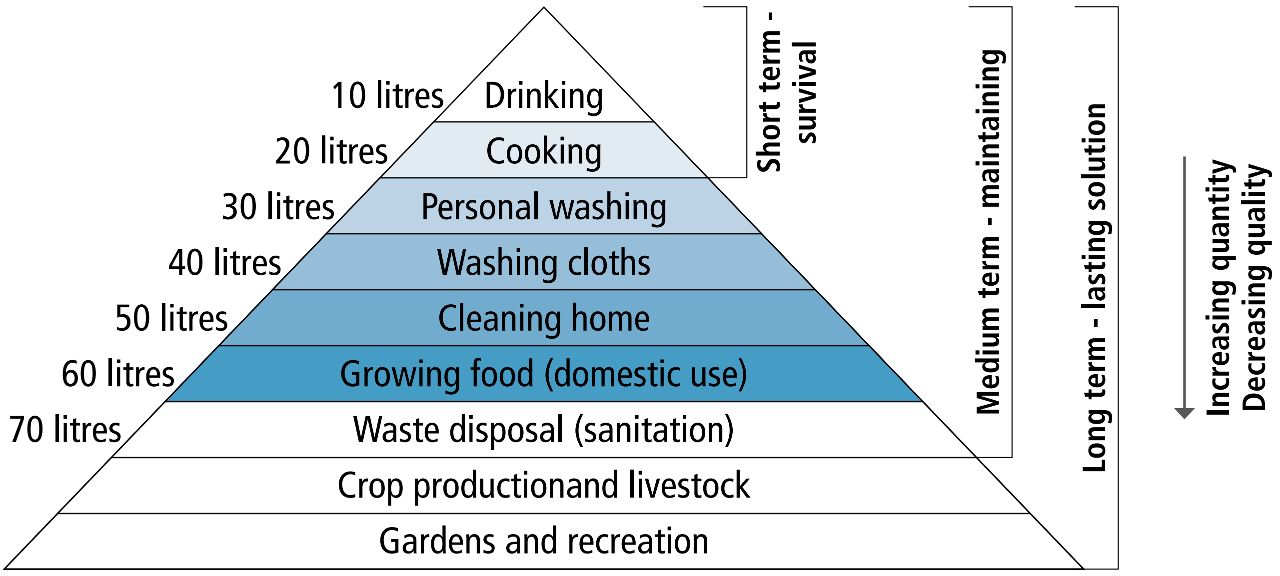
How to save 415 litres of wate in a day

Most sanitary ware outlets stock water-efficient fixtures

Fixture	Water use in standard fixtures	Water-efficient fixture	Water saved
Toilets	Single flush toilet uses 10-13 litres/flush	Dual flush toilet in 3/6 and 2/4 litre models	4-11 litres/ flush
Urinals	4litres; 10-13 litres if toilet pan is used	Sensor operated adjustable flush	2.2-10 litres pe flush
Taps	10-18 litres/minute depending on pressure	Sensor taps	5.5-15.5 litres/ minute
Showers	10-15 litres/minute	Flow restrictors	4-20 litres/minute

Source: Parryware Roca and others

How much water a person requires in a day



Textbook consumption of Indian cities

135 LITRES Per day per person

CLEANING OF HOUSE	10 LITRES
WASHING UTENSILS	10 LITRES
WASHING CLOTHES	20 LITRES
FLUSHING LATRINES	30 LITRES
BATHING (INCLUDING ABLUTION)	55 LITRES
COOKING	5 LITRES
DRINKING	5 LITRES