

CE412A:
2022-23 II

Design of Water Treatment & Waste Disposal Systems

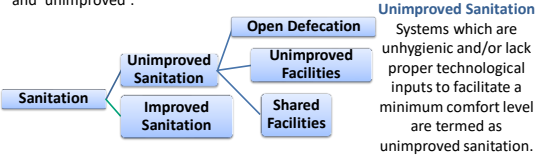
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Sanitation

A WHO Study Group in 1986 formally defined ‘sanitation’ as “the means of collecting and disposing of excreta and community liquid wastes in a hygienic way so as not to endanger the health of individuals and the community as a whole”. Based on the above definition, some types of sanitation are called “improved” while others are “unimproved”.

Unimproved Sanitation

According to World Health Organization, Sanitation can be classified as ‘improved’ and ‘unimproved’:



Sanitation

Open Defecation: When human feces is disposed of in fields, forests, bushes, open bodies of water, beaches or on railway tracks or other open spaces or disposed of with solid waste.

Unimproved Facilities: These facilities do not ensure hygienic separation of human excreta from human contact. Unimproved facilities include pit latrines without a slab or platform, hanging latrines and bucket latrines.

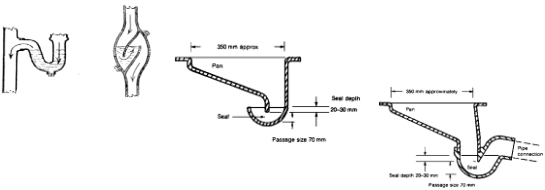
Shared Sanitation Facilities: Sanitation facilities of an otherwise acceptable type shared between two or more households. Only facilities that are not shared or not public are considered improved.

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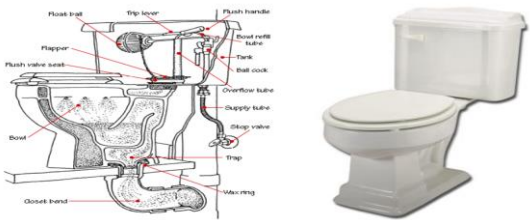
Improved Sanitation

Wet latrines are an important component of “improved” sanitation. Wet latrines are of two types, 1) flush latrines, 2) pour flush latrines.

Wet Latrines must have a P-Trap:



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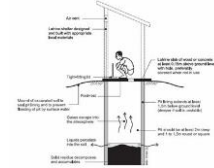


A P-Trap fitted to a toilet provides a water seal, which helps in odor control. Toilets with P-traps can easily be integrated with a flushing system.

Dry Sanitation

Single Pit Dry Latrine

Double Pit Dry Latrine



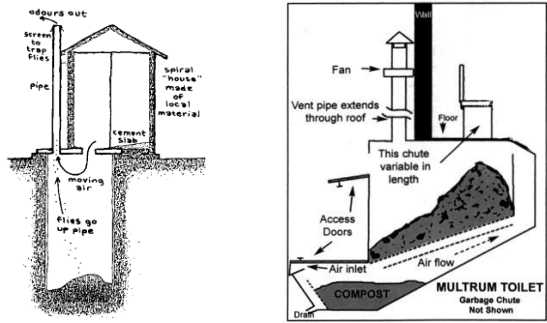
Such toilets should be used for a maximum of six months, then closed for six months, after which time the toilet contents should be removed and the toilet put back into operation. The toilet contents may be composted after mixing with garden waste, agricultural wastes or organic solid wastes.



Such toilets contain two pits. One pit is used for six months and then closed for six months. During this time the second pit is used. The first pit is put back into operation after six months and the second pit is closed.

Dry Sanitation

Ventilated Improved Pit (VIP) Latrine Composting Toilet



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Urine Diversion Dehydration Toilets (UDDT)

This is a type of dry toilet which can be adapted to accommodate anal cleaning water use.

UDDTs divert all liquids i.e. urine and anal cleansing water, from the feces to keep the processing chamber contents dry. UDDTs make use of desiccation (dehydration) processes for the hygienically safe on-site treatment of human excreta. Adding wood ash, lime, sawdust, dry earth etc. after defecation helps in lowering the moisture content and raising the pH. The system thus creates conditions of dryness, raised pH and pathogen die-off.

If wet anal cleansing habits prevail in a community, anal cleansing water must be diverted (by providing a separate washbowl) from the feces.

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Urine Diversion Dehydration Toilets (UDDT)



The main disadvantage is that some discipline is required during defecation. This has made adaptation of such toilets difficult.

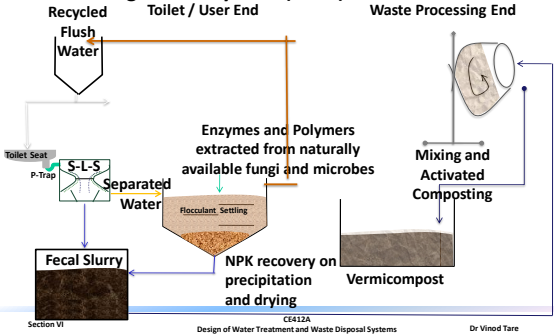
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Zero-Discharge Toilet System (ZDTS)



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Indian Sanitation Scenario - Up to 2012

		Year	1990	2000	2011
		Population (x1000)	873785	1053898	1241492
Urban	Percentage of Urban Population		26	28	31
	Improved		50	54	60
	Unimproved	Shared	17	18	20
		Unimproved	5	6	7
		Open Defecation	28	22	13
Rural	Improved		7	14	24
	Unimproved	Shared	1	3	4
		Unimproved	2	4	6
		Open Defecation	90	79	66
National	Improved		18	25	35
	Unimproved	Shared	5	6	7
		Unimproved	3	5	6
		Open Defecation	74	63	50

Sanitation

A critical assessment of traditional sanitation practices and present sanitation conditions in India leads to following observations:

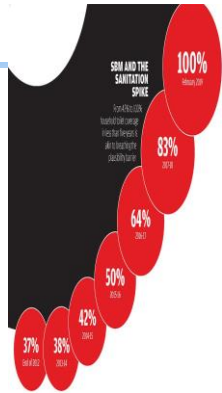
Open defecation cannot be recommended under any circumstances. This practice does not allow defecation with dignity and privacy and may be unhygienic if done improperly. Toilets that need daily manual cleaning are not recommended under any circumstances since they offend basic human dignity and contravene the Manual Scavenging Act. Hanging toilets, i.e., toilet constructed directly over water bodies or cesspools cannot be recommended under any circumstances. Such toilets create extremely unhygienic conditions.

Indian practice of using anal cleansing water renders the use of pit latrines (dry sanitation) difficult. The pits cannot be maintained dry and this leads to odor and fly problems. Defecation under such conditions becomes unhygienic and uncomfortable, and people soon abandon pit latrines and revert to open defecation.

Use of Urine Diversion and Dehydration Toilets (UDDT) is difficult, since the present models require following a certain discipline during defecation. An improved version of UDDT, specially attuned to Indian conditions is required.

Sanitation

Swachh Bharat Mission: Sanitation Boom



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Sanitation → Flush Latrines: Back-End

A flush toilet with a P-trap and connected to the sewer system is the most desired alternative. However, such systems may always not be possible in many areas due to the absence of a sewer system. Other alternatives are,

1. Sewage from flush latrines flow into natural depressions / ponds in the locality and evaporate or infiltrate into the ground. This creates an unhealthy and aesthetically depressing scenario.
2. Sewage from flush latrines flow in surface drains and then into natural rivulets ('nalas') and finally into rivers. Surface drains often do not have the slope to provide the required self-cleansing velocity to the flowing sewage leading to solids deposition and choking / overflowing of the drain. Such drains have to be cleaned regularly.

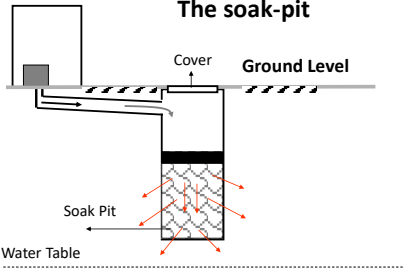
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The soak-pit



The soak pit chokes after some time.

Soaking sewage may cause groundwater pollution.

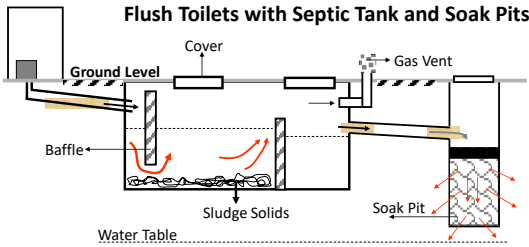
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Flush Toilets with Septic Tank and Soak Pits



Septic Tank Cleaning issues

The soak pit chokes after some time.

Soaking sewage may cause groundwater pollution.

The effluent from septic tank is called septage. When soak pits are choked, the septage often flows over ground. Sometimes the septage outlet is connected to surface drains. Septage management is a huge problem.

Sanitation

Small-Bore Sewer System

Small bore sewer system, also known as solids free sewer, divides the sewage into two components at the source itself using an interceptor (similar to a septic tank). One is the decanted liquid fraction (supernatant of the sewage) and the other is settled sewage solids (sludge). The solids which accumulate in the interceptor tanks should be removed periodically for safe disposal. Sewer lines are designed to receive only the liquid portion of household wastewater for off-site treatment and disposal.

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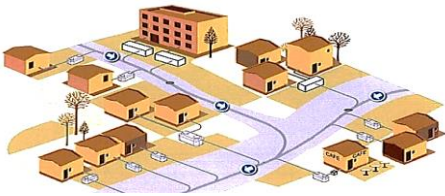
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Small-Bore Sewer System

SBS system requires small diameter piping because it conveys only liquid, hence it is economical. Because of the lower costs of construction and maintenance and the ability to function with little water, small bore sewers can be used where conventional sewerage would be inappropriate.



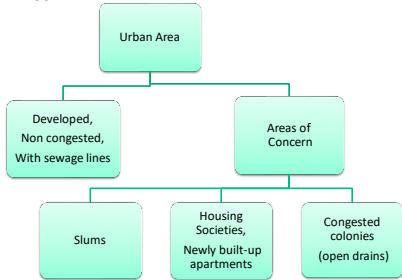
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Different Types of Human Settlements in Urban Areas



Sanitation solutions are different for each of these areas.

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Different Types of Human Settlements in Rural Areas

Congested settlements ("Mohallas")
Relatively well-off
Relatively poor

Dispersed settlements
Relatively well off
Relatively poor

Sanitation solutions are different for each of these areas.

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A critical assessment of traditional sanitation practices and present sanitation conditions in India leads to following observations,

Flush and pour-flush latrines are definitely the way to go considering typical Indian conditions. However, the problem of supplying water for flushing such toilets is an issue in many areas.

Even if water is provided, flush and pour-flush latrines connected to open drains are problematic. Since the open drains follow the contours of the ground, in flat areas slopes cannot be maintained for flow of sewage at self-cleansing velocities. This leads to the deposition of sewage solids in the drain and subsequent choking and overflowing of the drains, creating unhygienic conditions.

Flush and pour-flush latrines connected directly to soak pits or connected to septic tanks followed by soak pits is problematic in congested areas, especially when water table is high. The chances of groundwater pollution are very high under such conditions.

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Flush and pour-flush latrines connected to small bore sewer system may be a viable option in congested areas in Indian context.

Shared or communal toilet facilities must be given due importance, specially in slums. Such facilities, which are conceptually different from public toilets, may be the only workable solutions under certain conditions.

The cost of adequate sanitation in India, i.e., when both 'front-end' and "back-end" is taken care of, is Rs. 5-20/person/d. This is irrespective of what sanitation solution is adopted.

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