Green and Sustainable Technologies
2 Credits
Water Use Efficiency in Sustainable Built Environment

Water Use Efficiency

- **Buildings use 25% of water.**
- ***Water efficiency*** is a key component in Sustainable Green Buildings

What is water efficiency?

- According to the US EPA,

water efficiency is the smart use of our water resources through water saving technologies and simple steps we can all take Using water efficiently will help ensure reliable water supplies today and for future generations

- Most buildings rely on municipal sources of potable water to meet their needs, from flushing toilets to washing dishes and landscape irrigation

- Furthermore, large amounts of wastewater can overwhelm treatment facilities, and the untreated overflow can contaminate rivers, lakes, and the water table with bacteria, nitrogen, toxic metals, and other pollutants

Wastewater:

domestic wastewater = sewage = all wastewater

industrial wastewater = process wastewater

Greywater: domestic wastewater except toilet & kitchen wastewater

Blackwater: domestic wastewater from toilets and kitchens

Reclaimed Water

- derived from sewage
- treated to a standard satisfactory for intended reuse

Storm water

- Maintain natural hydrologic period of site
- Use natural systems to buffer flows

Alternate Waters :Waters other than treated Tap Water

- **Gray Water**
- **Reclaim Water**
- **Rainwater**
- **Groundwater**
- **Condensate recovery**

Key options to improve water efficiency

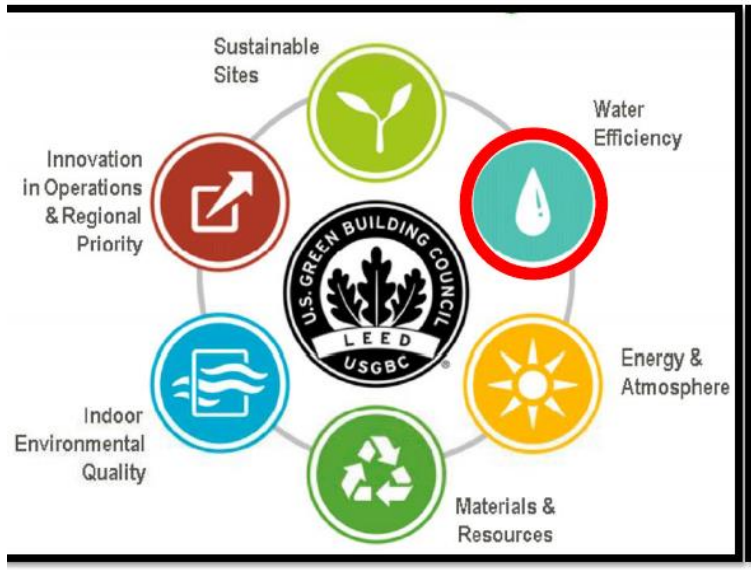
1. Better Water Management?
2. Reduce usage?
3. Reduce pollution? or
4. Improved Water Efficiency?

To Conserve Water Resources

- In this regard Emphasis on Improved Water Efficiency in Green Building is one **important initiative**

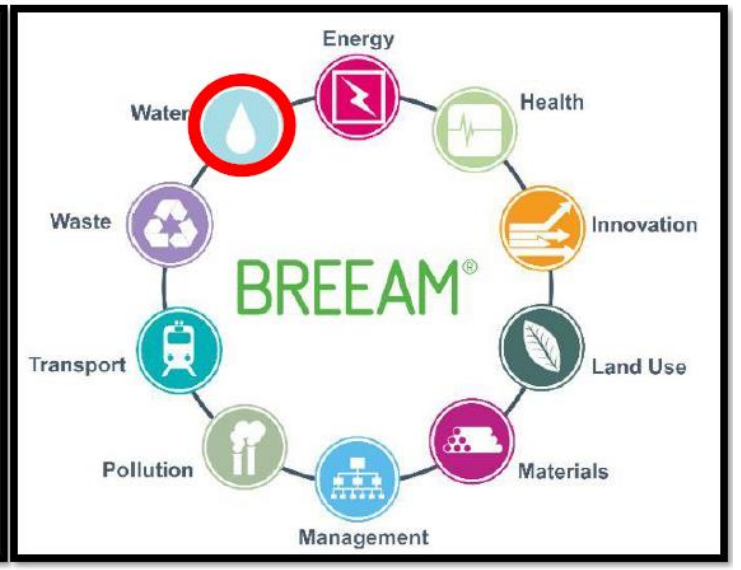
- **Water efficiency is a priority in numerous national green building programme.**

LEED Credit Categories



Leadership in Energy and Environmental Design (LEED), US

BREEAM Assessment



Building Research Establishment Environmental Assessment Method (BREEAM), UK

In *GREEN SL* Rating System by SLGBC, **Eight** performance criteria are set for;

1) **Management - 4 points**
2) **Sustainable Sites-25 points**
3) **Water Efficiency- 14 points**
4) **Energy and Atmosphere - 22 points**
5) **Materials and Resources - 14 points**
6) **Indoor Environmental Quality- 13 points**
7) **Innovation and Design Process - 4 points**
8) **Social and Cultural Awareness - 4 points**

- Certified 40–49 points
- Silver 50–59 points
- Gold 60–69 points
- Platinum 70 points and above

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In Green Concept, Water Efficiency is achieved through

- Reduce wastewater generation
- Reduce potable water demand
- Reduce waste/pollution release into the environment and
- Increasing the local aquifer recharge

Where alternate waters are commonly used in;

- irrigation,
- green roofs,
- cooling tower makeup water,
- toilet and urinal flushing,
- makeup for an ornamental pond/fountain
- swimming pools,
- laundry,
- process use, and
- aquifer recharge and wetlands maintenance.

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How Alternative Water can be used in Buildings :

Water end use	Rainwater	Greywater
Landscape irrigation	Yes	Yes
Toilet flushing	Yes	Yes, but treated
Edible garden irrigation	Yes	Yes, but treated
Car washing	Yes	Yes, but treated
Washing machine	Yes	Yes, but treated
Dishwasher	Yes	No
Swimming pool	Yes	No
Showers	Yes	No
Drinking and cooking	Yes, however only recommended where no reticulated drinking water is available.	No

GREENSL® rating system for built environment:

14 Total Points in total (out of 100) is available for water efficiency

Eliminate potable water consumption for irrigation and landscaping	Required
Use of alternative water sources	**1 point**
Use of water-saving performances	**1 point**
Indoor water use reduction	**1-4 points**
Water Efficiency in air conditioning system	**1 point**
Innovative Wastewater Technologies	**[1-5 Points]**
-Reduce Potable Water Use	1 Point
-Reduce Potable Water Use or Treat Wastewater	1 Point
-Harvested rainwater	2 Points
-Aquifer Recharge	1 Point
Innovative Water Transmission	**1 Point**
Ground Water Recharge, if Ground Water Sources are Tapped	**1 Point**

Greensl® Rating System For Built Environment – Water Checklist

WATER EFFICIENCY

14 Total Points in total (out of 100) is available

1.Water Efficient Landscaping [Required]

2.Alternative Water Sources 1 Point

3.Water Saving Performances 1 Point **4.Indoor Water Use Reduction** 1-5 Points

5. Water Efficiency in Air-conditioning System 1 Point

6. Innovative Wastewater Technologies 1-5 Points

7. Innovative Water Transmission 1 point

SUSTAINABLE SITES

4 Total Points in total (out of 100) is available

1. Storm Water Design, **Quality Control** 2 Points2 Points
2. Storm Water Design, **Quantity Control**

Greensl® Rating System For Built Environment - Checklist

Eliminate potable water consumption for irrigation and landscaping [**Required**]

Use only captured rainwater, treated grey water and air conditioner condensate etc. to eliminate all potable water use for site irrigation (except for initial watering to establish plants)

Eliminate Potable Water Consumption

- Use high efficiency irrigation technologies or
- Use rainwater or gray water to reduce potable water use for irrigation
- Use native plants that tolerate the climate, wastewater reuse
- Rain fed irrigation system, use of air-conditioning condensate

1. Irrigation System and Landscaping for Improved Water Efficiency

Provision of suitable systems that utilize rainwater or recycled water

- Use of non potable water including **rainwater** for landscape irrigation.
- Use of automatic water efficient irrigation system with rain sensor.

Use of plants that require minimal irrigation to reduce potable water consumption

- Use of drought tolerant plants that require minimal irrigation (***≤1Liter/m²***) .

Irrigation System and Landscaping for Improved Water Efficiency

- **The irrigation of lawns and gardens consumes up to 50% of the potable water we bring onto our property, and much of that just ends up as runoff, rather than being absorbed by the plants being watered**

- **Install efficient irrigation systems such as drip irrigation, soil soakers, and**
  - **efficient sprinkler systems**

- **Install smart, programmable sprinkler systems and moisture sensors that allow you to measure the amount of water your yard needs at any given time, and control irrigation from a central shut-off valve**

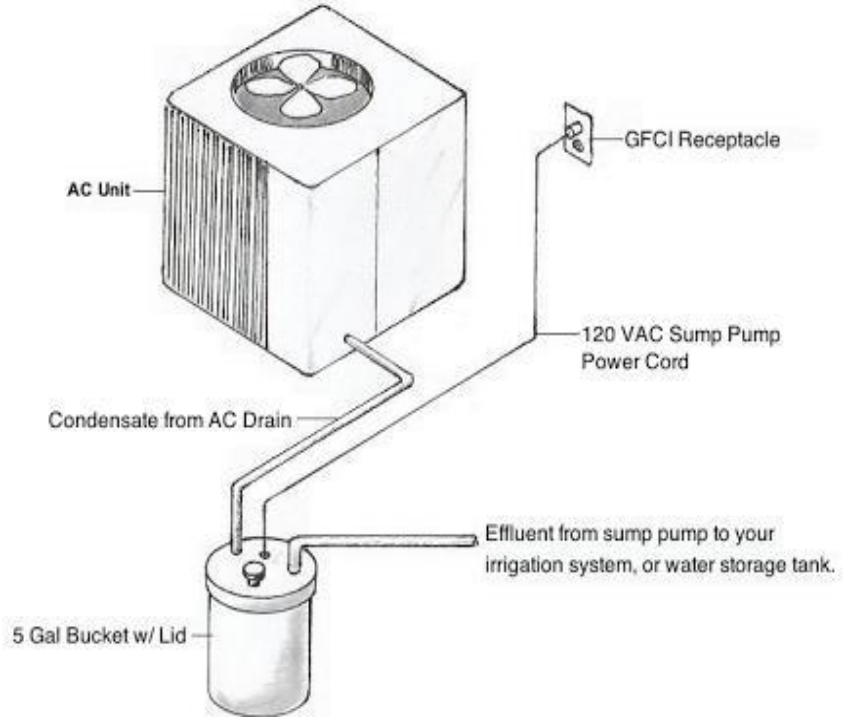
2. Water Efficiency in Air-conditioning System

Objective – limit or eliminate the use of potable water for air- conditioning make-up water while using condensed water for irrigation

Hints:

- *Use water efficient chillers and cooling towers*
- *Use rain water or recycled gray water for make-up*
- *Use of cooling tower water treatment system which can achieve better cycles of concentrate at acceptable water quality.*

2. Water Efficiency in Air-conditioning System



3. Innovative Wastewater Technologies [1-5 Points]

Objective – Reduce potable water demand and wastewater generation, increase local aquifer re-charge

Reduce Potable Water Use or Treat Wastewater

- Reduce the use of NWS&DB supplied water
- 100% on-site treatment of wastewater to required standards

Hints:

- ***Consider reusing storm water or gray water for sewage conveyance***
- ***Direct treated wastewater into aquifer recharge***
- ***Two plumbing system to separate black from gray water***

100% on-site treatment of wastewater to required standards

Wastewater Treatment :

Use onsite low resource consuming appropriate technologies.

- *Septic Tank with Soaking*
- *Natural systems such as use of wetlands*

Waste stream segregation

Treat wastewater up to recycle standards

Harvest rainwater

Domestic Wastewater Disposal System

- Typically Domestic Sewage in general is separated into;
  - Toilet wastewater
  - Kitchen wastewater and
  - Other wastewater

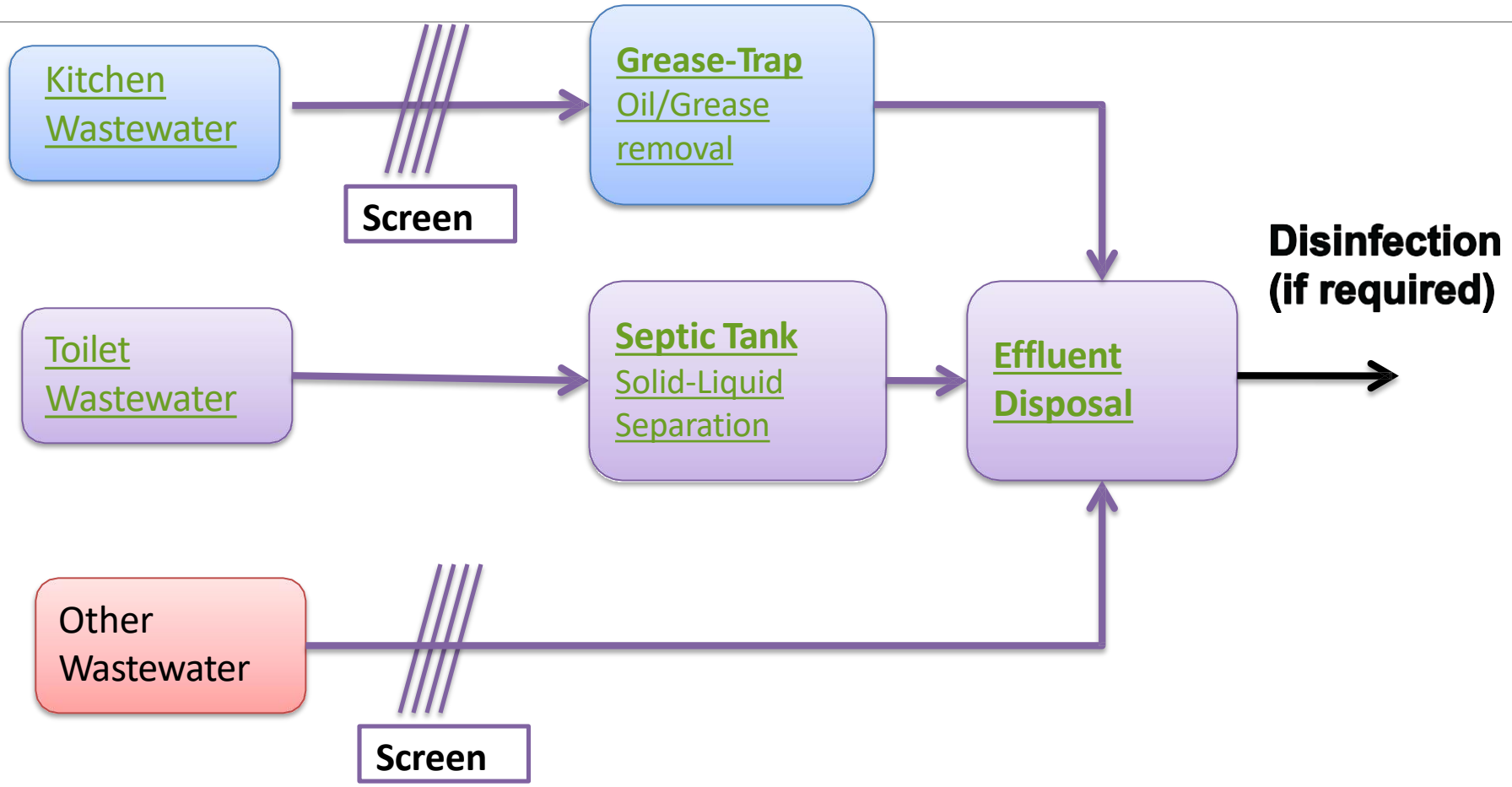
- Why this Separation is important??

  ❖ Toilet wastewater contains **solids, high strength** liquid waste and **pathogens**

  ❖ Kitchen wastewater contains **oils and grease**

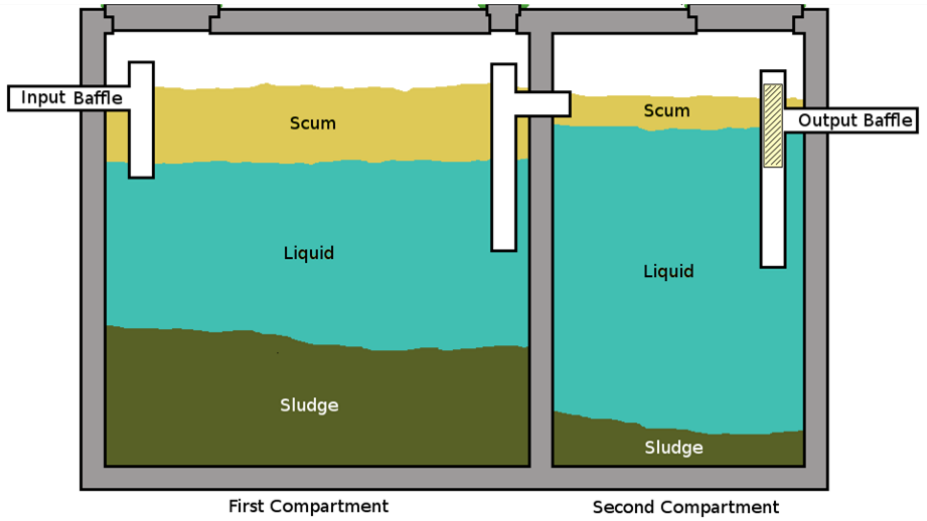
  ❖ Other wastewater are generally of **low strength, requires only limited treatment** and can be recycled easily

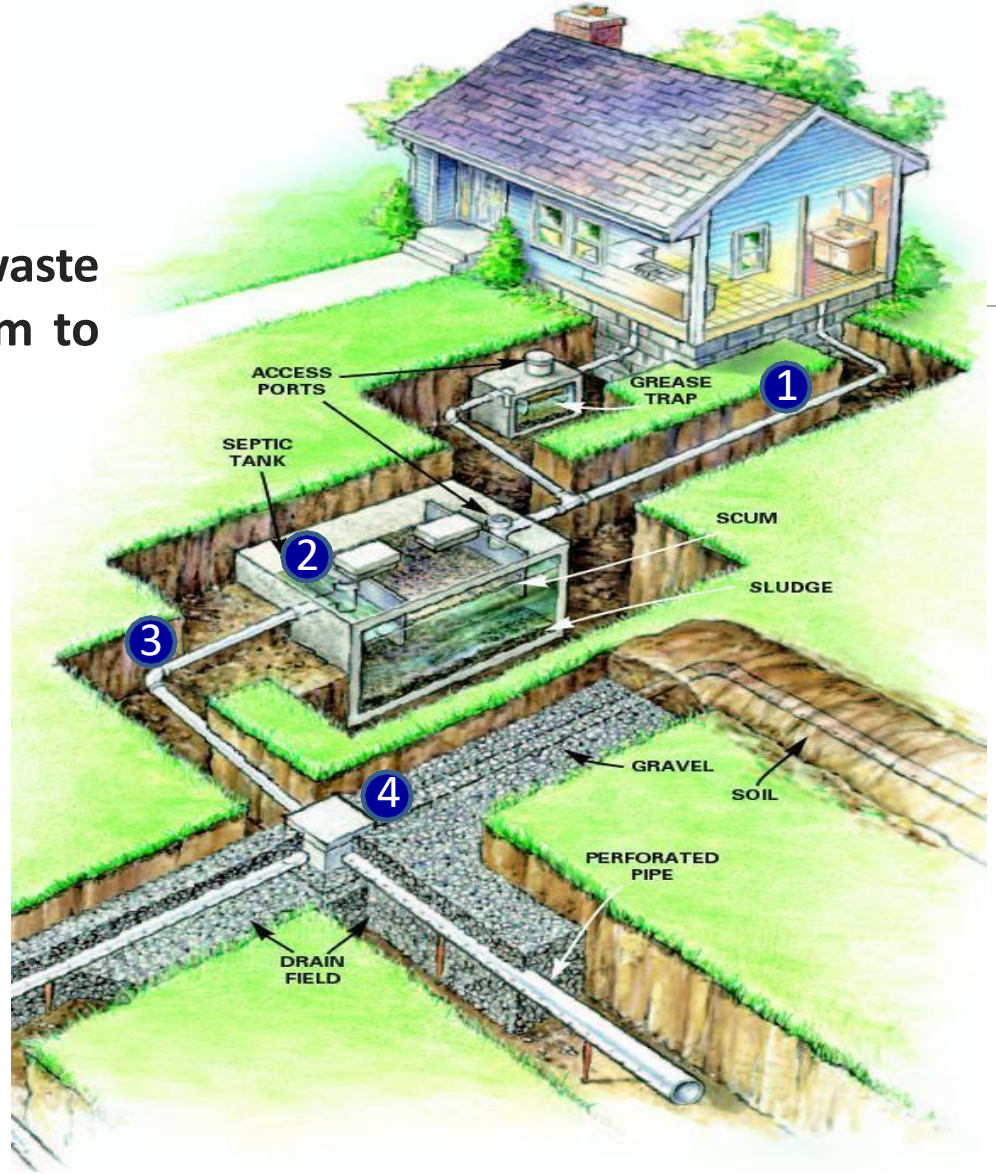
A typical onsite wastewater disposal system



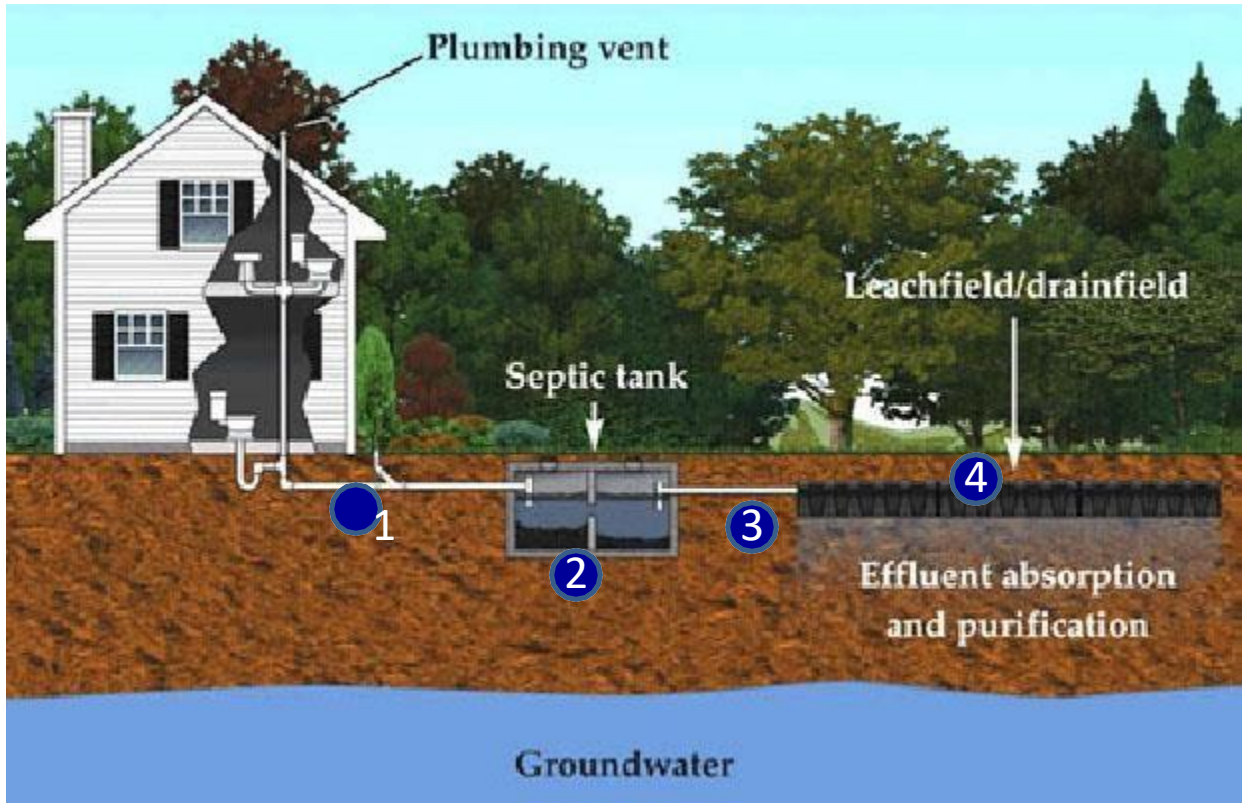
Typical Septic tank system :

1) **The main sewer line**, which is also called the waste line, connects the home's indoor plumbing system to the septic tank outside of the home.



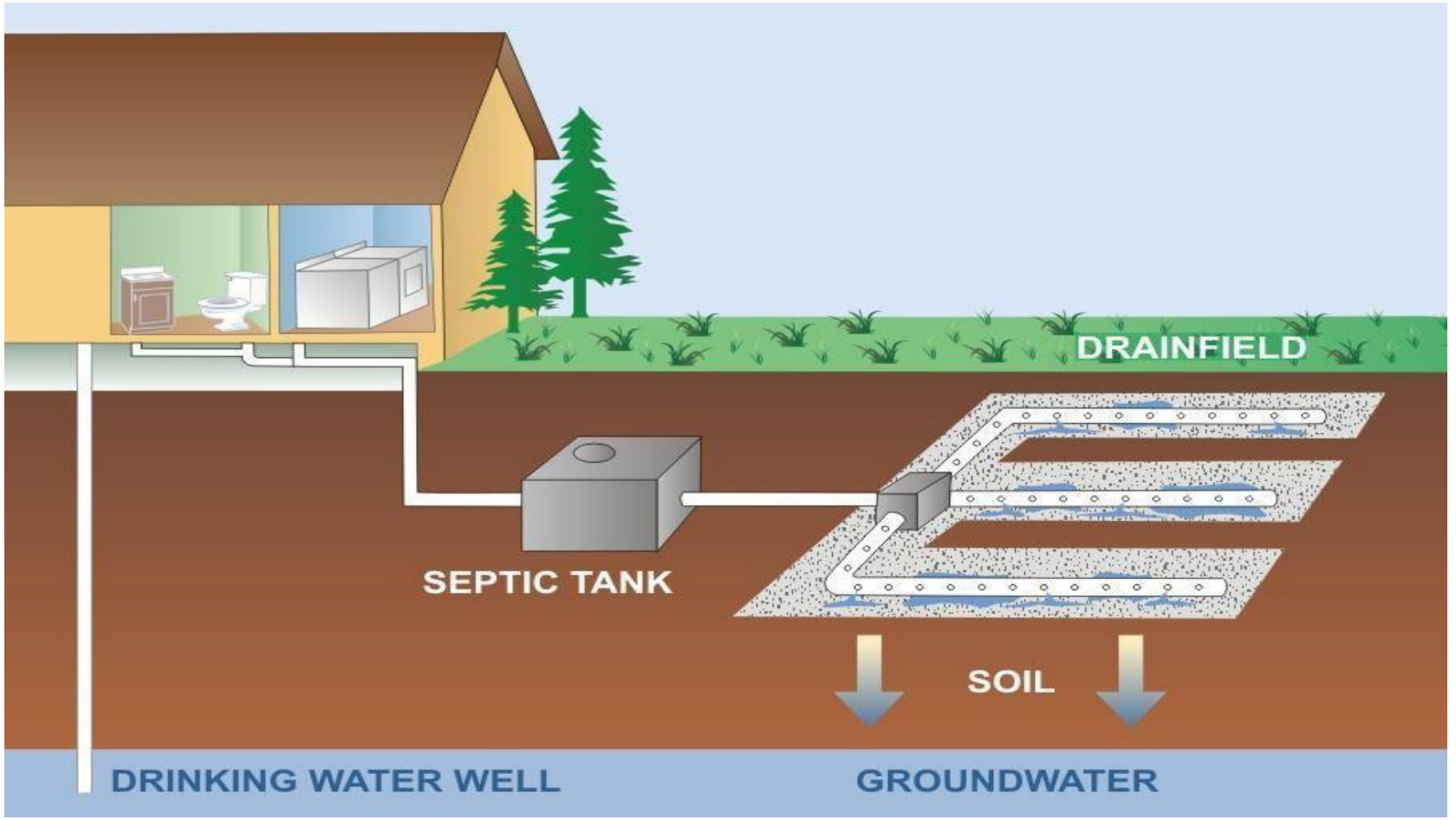


2) **The septic tank**



3) The **effluent distribution pipe** directs the flow of the liquid waste from the septic tank to the leaching system farther out into the yard. Distribution boxes are often present to help evenly distribute the flow throughout the system.

4) **A leaching system (Drain Field)**, or soil absorption system, is also sometimes called a drain field or leach field. This is a network of perforated pipes that extends into a specific area of the yard. These pipes are usually buried in gravel trenches and the effluent that flows out of them disperses into the surrounding natural soils


DRAINFIELD
SEPTIC TANK
SOIL
DRINKING WATER WELL
GROUNDWATER

Septic Tank :

- Septic Tanks must be water tight
- Inlet – Outlet through ‘T’ connections
- Tank should be above the high season groundwater level (>1.5m)
    - Need regular inspection
- Essential to have a ventilation pipe

Leaching Field :

- Good soaking ground
- High season groundwater level should be at sufficiently deep
- Distance away from drinking wells (>18m away)

Constructed/Natural Wetland :

A wetland is a land area that is saturated with water , either permanently or seasonally, such that it takes on the characteristics of a distinct ecosystem

Natural wetland systems have often been described as the "**earth's kidneys**" because they filter pollutants from water that flows through on its way to receiving lakes ,streams and oceans

- Constructed wetlands are artificial wastewater treatment systems consisting of shallow (usually less than 1 m deep) ponds or channels which have been planted with aquatic plants, and which rely upon natural microbial, biological, physical and chemical processes to treat wastewater.

- They typically have impervious clay or synthetic liners, and engineered structures to control the flow direction, liquid detention time and water level.

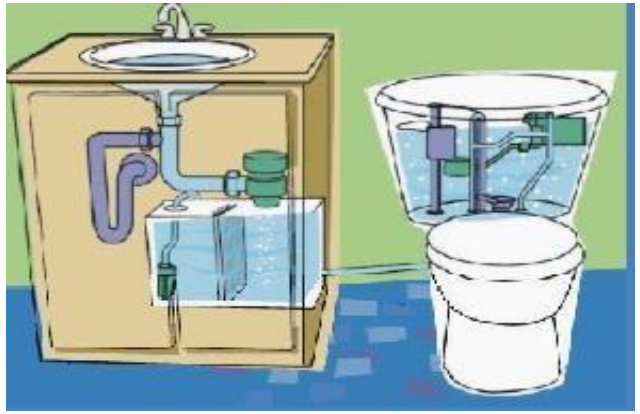
- By various such process chemicals are considerably removed or settled and clean water is drawn. These chemicals include Nitrogen, Ammonia, Phosphorous and pathogens.

- Constructed wetlands are most economical as compared to conventional treatment units which needs more energy for its process and this method require cheaper materials

Reduce the use of NWS&DB supplied water

Use of greywater in flushing

Alternative sources of water can be used to flush toilets and urinals. In particular, water consumed in showers, wash basins, and laundry operations – so-called greywater – can be reused. Greywater reuse in toilets, however, requires the installation of extra pipes, pumps, a storage unit, and a simple treatment unit. It can be costly to retrofit existing toilets and urinals with a greywater collection system. It is much more feasible to introduce a system for collecting and treating grewater for reuse during the design phase.



Use bath water for washing machines (Eg: in Japan)

Most of Japanese washing machines come with an extra hose for pumping water, which connect to a special valve at the back of the machine.
This can pump water from bath tub to the washing machines. Some machines may have an external pump that is on the filter end of the hose.

Laundry-to-Landscape:

This greywater system doesn't alter the household plumbing: the washing machine drain hose is attached directly to a diverter valve that allows you to switch the flow of greywater between the sewer/septic and the greywater irrigation system. This system is low cost, easy to install, and gives huge flexibility for irrigation.

The larger the irrigation area (minimum recommended area is 150–200 m^2), the more you'll spread the chemical load. Its better **not to put greywater onto the edible portion of plants**. Greywater should **irrigate the roots**, not be sprayed or dumped onto the plant itself.

- Rainwater is widely recognized as a valuable water resource and it can provide a readily accessible water supply
- Rainwater harvesting systems vary from the small and simple to the large
  - and complex ones
- Where a suitable harvesting surface exists, such as roof or even road, rainwater collection can provide sufficient and low cost source of water for non-portable usage
- Effectively use of rainwater as a supplementary water supply can indirectly beneficial for flood control too
- Rainwater can be regard as better quality water than treated wastewater and is likely to be suitable for wide range of potable and non-potable applications, Cooking
  - *Laundry use*
  - *Toilet flushing*
  - *Car and equipment washing*
  - *Garden irrigation*
  - *Industrial processes*

Limitation of Rainwater Harvesting:

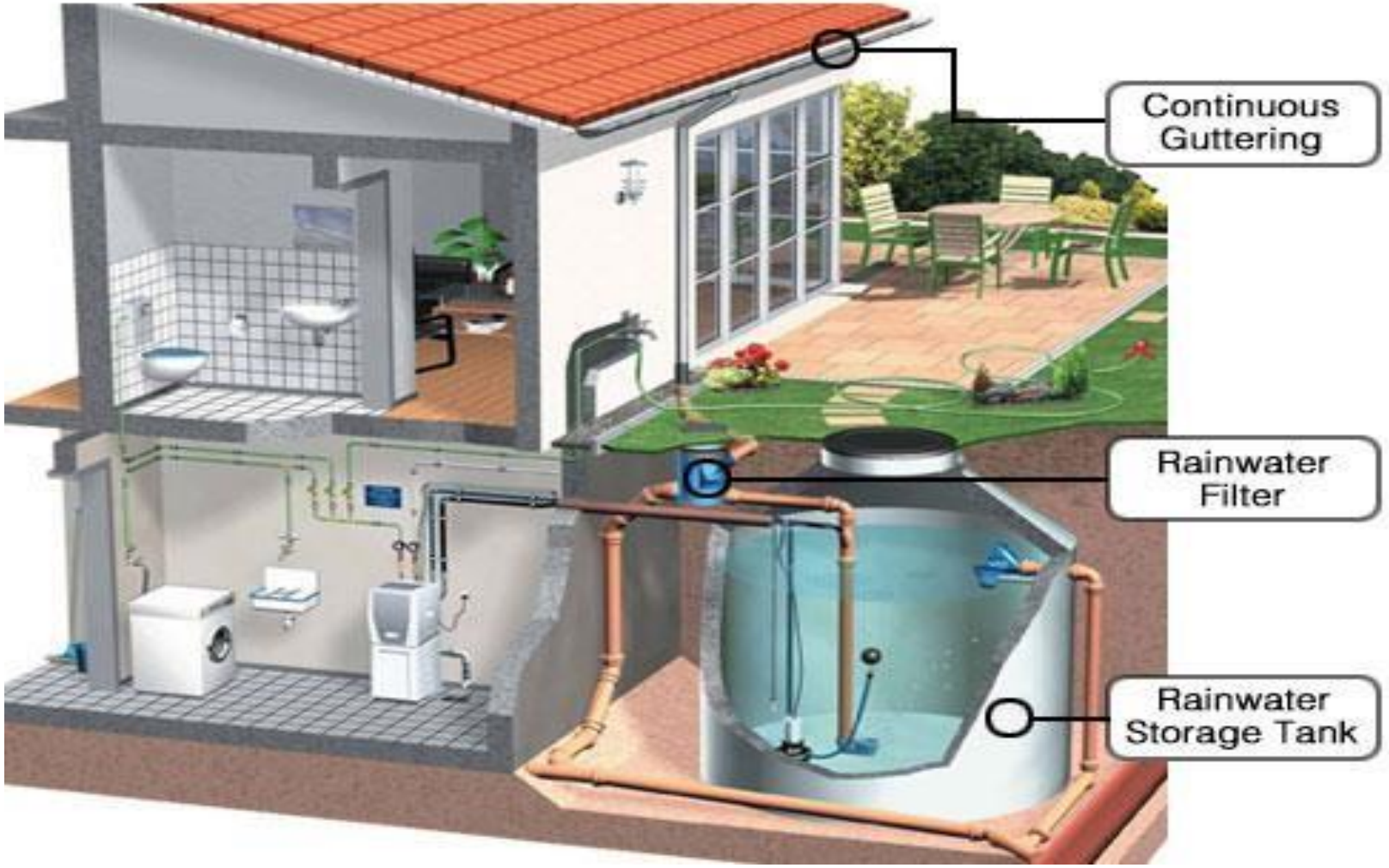
- Not a stable water source because the amount largely is dependent on the variability of weather and climate

- Leaching from roofing, guttering and plumbing materials or materials of storage tank may degrade the quality of rainwater

Solution:

- As rainfall is typically unevenly distributed throughout the year, rainwater collection can serve as a supplementary method to support household and municipal water use

- Rainwater may be used along with other stable water supply from surface water or/and groundwater at household or community scale level from the viewpoint of sustainable water use


Continuous Guttering
Rainwater Filter
Rainwater Storage Tank

How do You Improve Your Harvested Rainwater's Quality?

- Here are key recommendations to protect the quality of your harvested rainwater:

- Install a "first-flush diverter device" between the roof downpipe and the rainwater
  - storage tank to dispose of the first rainfall runoff collected by your roof.

- Install filtering screens and clean roofs on a regular basis to remove dust, leaves, bird feces, and other impurities to improve water quality and reduce the clogging of gutters and collecting systems.

- Clean tank water on a regular basis to reduce sediment deposits and water
  - contamination.

- Add disinfecting agents such as chlorine to reduce biological contamination.

- Locate rainwater storage tanks far from contamination sources such as sewage
  - networks.

- Regularly monitor storage-tank water quality to assess, especially, potential
  - bacteriological contamination

4. Water Use Reduction

Objective – Further increase water efficiency within building to further reduce NWSDB water use, volume for waste water treatment

Employ strategies to use less water than the baseline values

Examples for Baseline Values:

Commercial – toilet 6 lpf, urinals 4 lpf, faucets – 9 lpm etc.

Residential – toilet 6 lpf, faucets – 8 lpm at 4 bar pressure, showerhead 9 lpm at 5 bar pressure

Hints:

- *Use of high efficiency fixtures, use of dry systems*
- *Use of alternate water for non-potable use*

Water consumption in typical residential environments can be reduced between 19% - 44% using low-flow fixtures:

Water Efficient Fittings

Encourage the use of water efficient fittings;

- Basin taps and mixers
- Flushing cistern
- Shower taps, mixers or showerheads
- Sink/Bib taps and mixers
- Urinals and urinal flush valve

Water Usage and Leak Detection

- Promote the use of sub-metering and leak detection system for better control and monitoring.
- Provision of private meters to monitor the major water usage such as irrigation, cooling tower and tenants' usage.

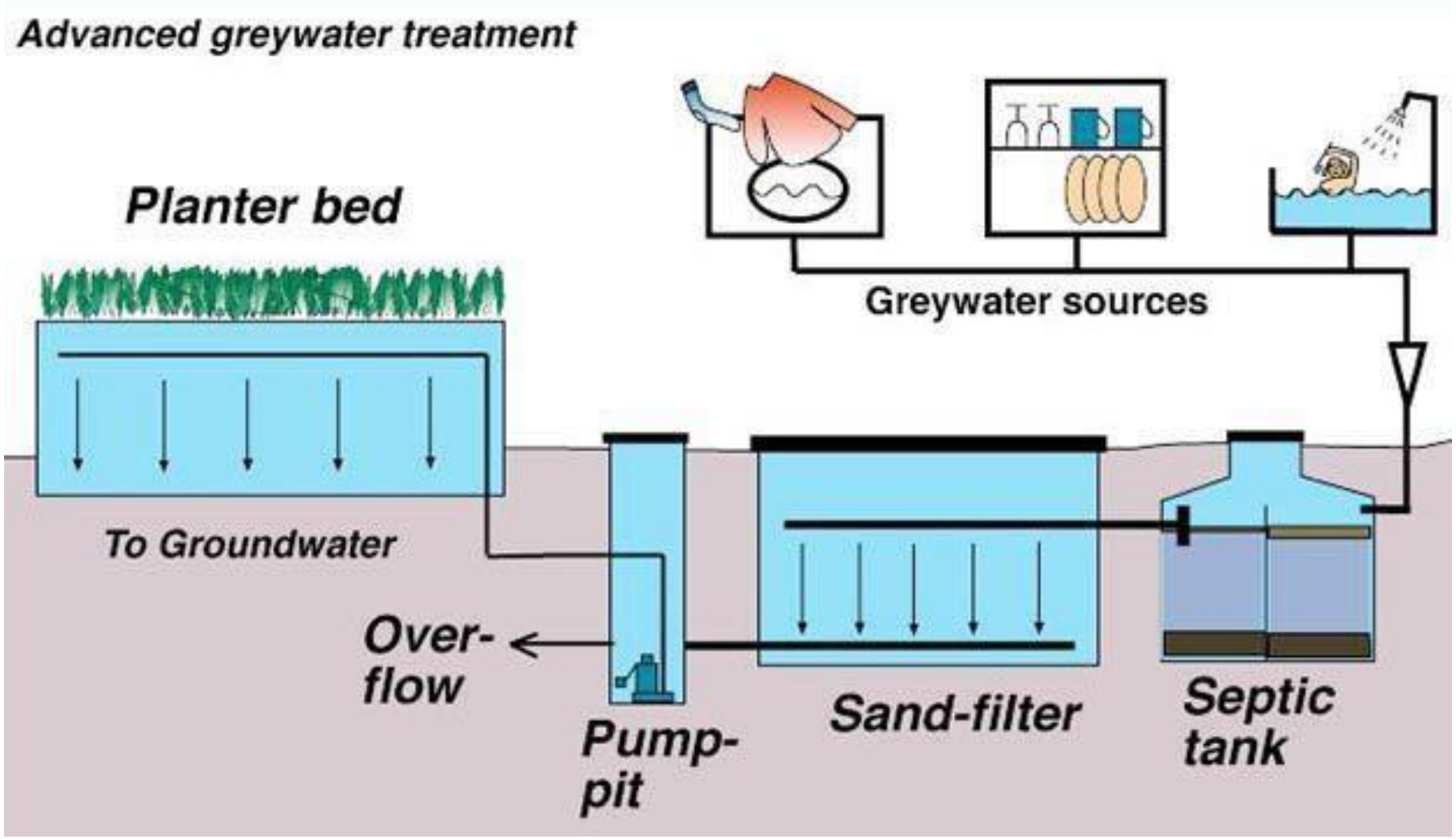
High Efficiency Toilets (HETs)

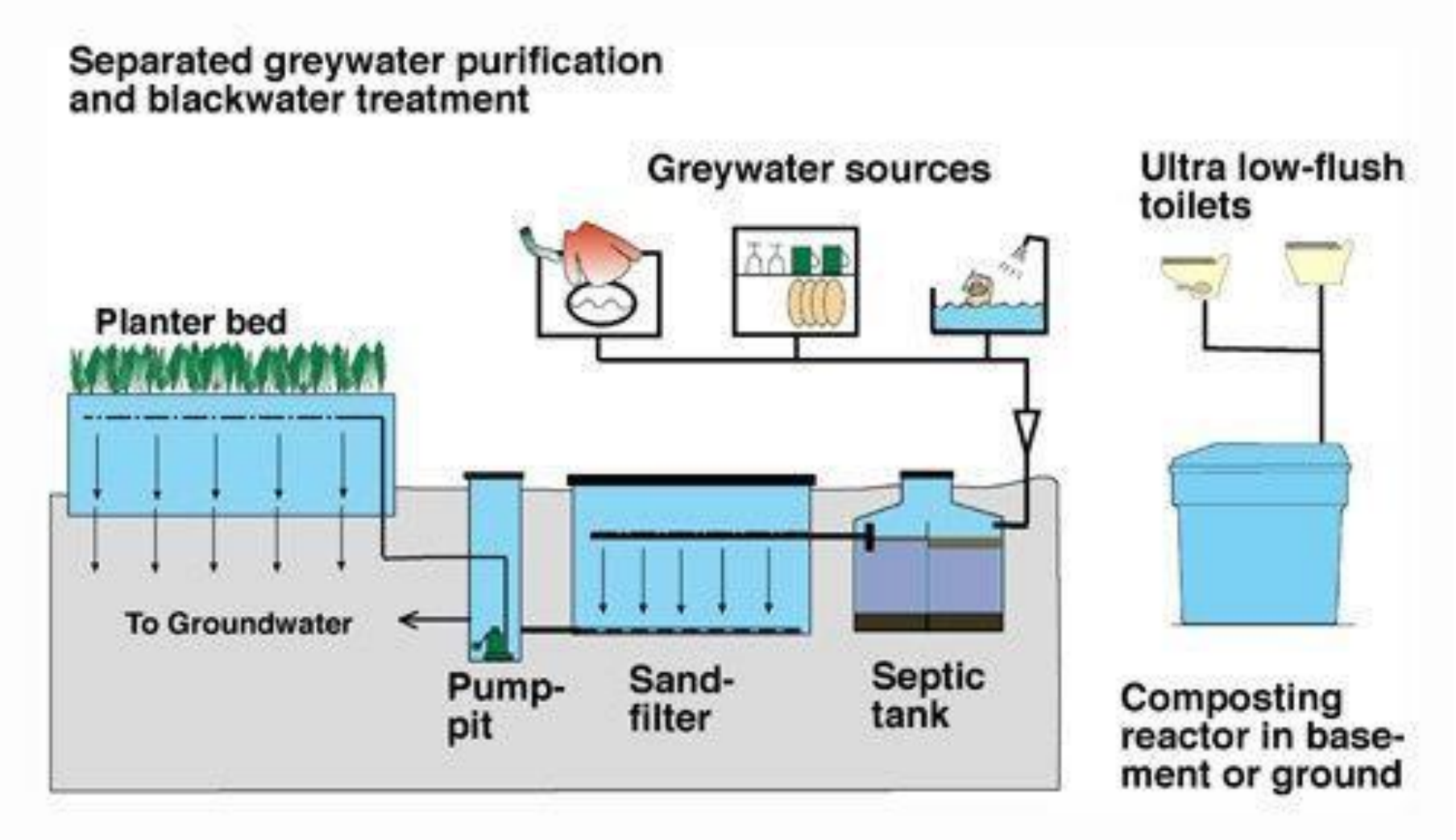
- The toilet is the single biggest water user in buildings. Flushing accounts for about 35%, more than a third, of the water used within buildings each day.
- Replacing an old model toilet with a new low-consumption toilet could automatically and permanently cut water consumption by 25% or more.

Water saving shower heads :

- **Shower accounts for about 30 % of the total household water consumption**

- **A reduced shower head flow rate will reduce water consumption during bathing, without sacrificing user satisfaction and can save more than 40% of your water bill**


Advanced greywater treatment
Planter bed
Greywater sources
To Groundwater
Over-
flow
Pump-
pit
Sand-filter
Septic
tank


Separated greywater purification
and blackwater treatment
Greywater sources
Ultra low-flush
toilets
Planter bed
To Groundwater
Pump-
pit
Sand-
filter
Septic
tank
Composting
reactor in base-
ment or ground

Reuse of waster has several advantages:

- **Reduces demand for higher-quality water**
- **Reduces wastewater discharge subsequently**
  - **reducing water pollution**
- **It is economically efficient since it minimize the water transporting cost from distant sources**

- **Drawbacks:**
- **Additional costs and energies are needed for advanced**
  - **treatment**
- **If not well managed reclaimed water may generate**
  - **number of risk associated with public health**

5.Innovative Water Transmission

Objective – Limiting use of non-renewable energy for water conveyance

- ***Use localized sources like springs/groundwater to reduce conveyance***
- ***Use variable speed pumps, wind pumps, ramp pumps, solar powered pumps etc.***

Sustainable site category:

1. Storm water Design – Quantity Control [2 Points]

Objective – Limit disruption of natural water hydrology by reducing imperviousness by increasing on-site infiltration, reducing runoff

Implement a stormwater management plan to reduce runoff

Hints:

- *Design to preserve the natural stormwater flow (no reduction by the construction),*
- *Have infiltrating zones, vegetated roof, pervious paving etc, Reuse rainwater*

2. Storm water Design – Quality Control [2 Points]

Objective – Limit destruction and pollution of natural water flow Plan to reduce impervious cover, capture and treat 70% r/f Treatment to reduce 80% TSS

Hints:

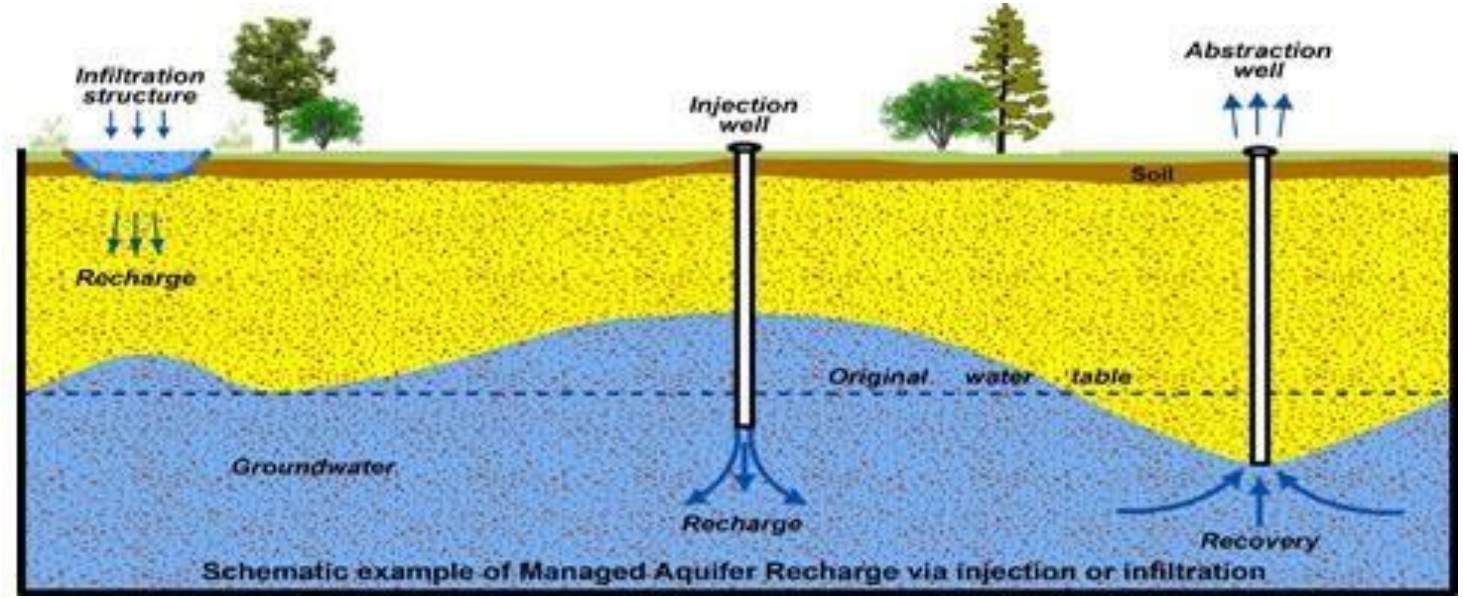
- *Use alternative surfaces to improve infiltration*
- *Have treatment systems such as wetlands, ponds etc.*

Ground Water Recharge, if Ground Water Sources are Tapped :

Objective:

To minimize the negative impacts on the ground water resource due to excessive extraction.

Recharge an equal amount of water extracted from the ground water

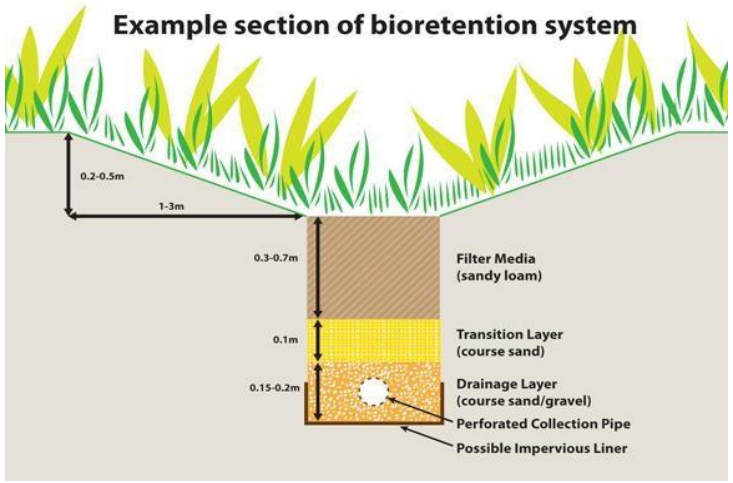


Storm water Management:

Encourage treatment of storm water run-off before discharge to the public drains.

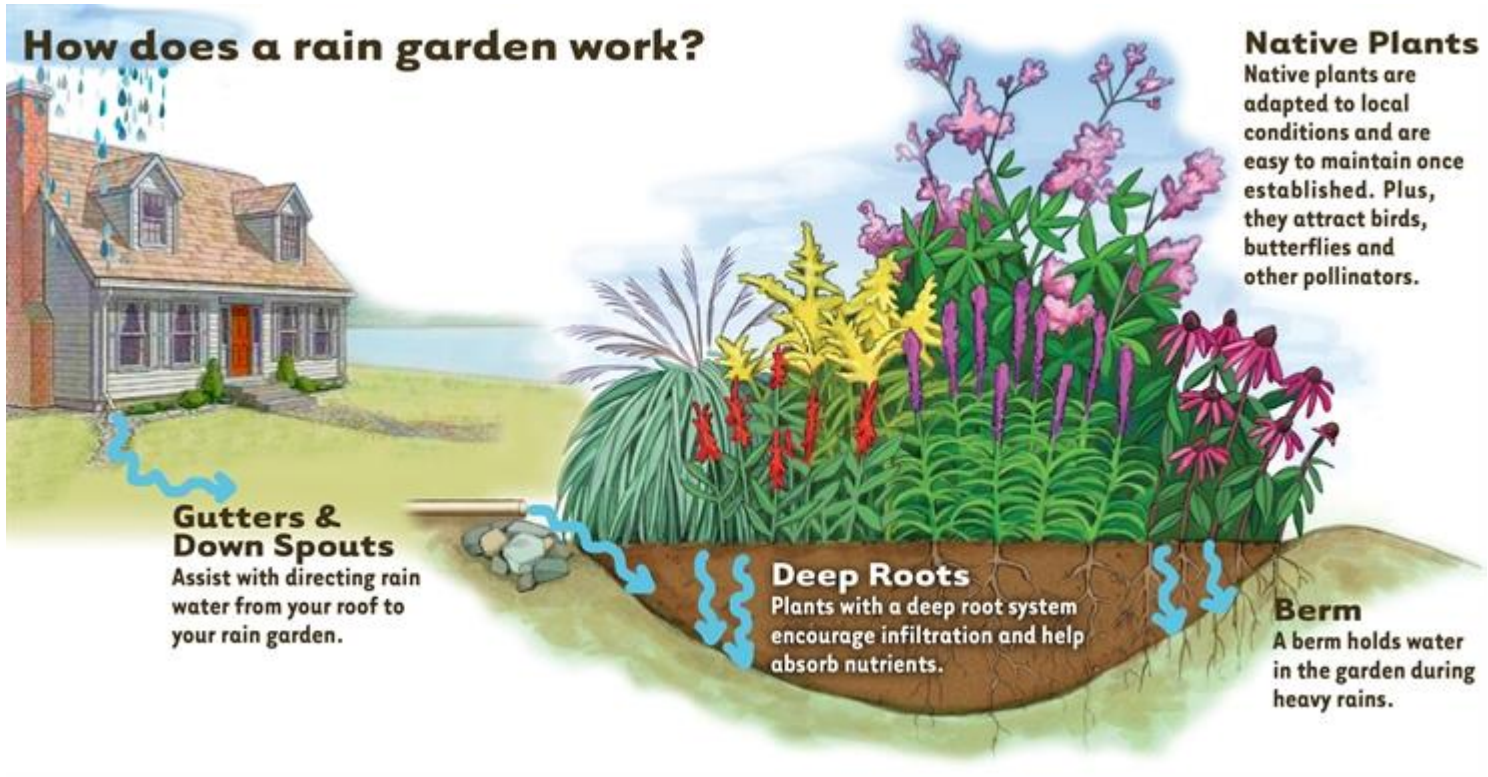
Provision of infiltration features or design features as;

- *Bio-retention swales systems*
- *Rain gardens*
- *Constructed wetlands*
- *Cleansing biotopes/Retention ponds*



Rain Gardens

Rain gardens are smaller or residential systems. These gardens have a slight depression to help collect water and are vegetated with plants that can withstand moisture regimes ranging from flooded to dry.



https://www.warrenswcd.com/rain-gardens.html

BIOSWALES

Bioswales achieve the same goals as rain gardens by slowing and filtering stormwater, but are designed to manage a specified amount of runoff from a large impervious area, such as a parking lot or roadway. Because they need to accommodate greater quantities stormwater, they often require use engineered soils and are deeper than rain gardens.