

Water treatment with natural methods



permaculture
design

courses

landscapes

projects

sector39





Eutrophication, run off of nutrients

BOD



- The biological oxygen demand is defined as the 'measure of dissolved oxygen required to decompose the organic matter in water biologically'
- Normally, it is measured over 5 days

Pollution = nutrients in the wrong place

Water treatment

- ▶ Grey water
- ▶ Contains:
 - ▶ Food particles
 - ▶ Mineral particles
 - ▶ Dissolved nutrients
 - ▶ Soap
 - ▶ Chemicals?
- ▶ Black water
 - ▶ Toilet waste
 - ▶ Nutrients in high concentration
 - ▶ Pathogens
 - ▶ Breakdown products of digestion
 - ▶ Other chemicals?



Urine separating toilets

Urine composition

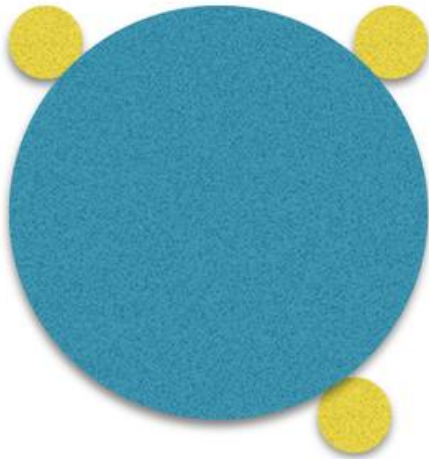


Urine

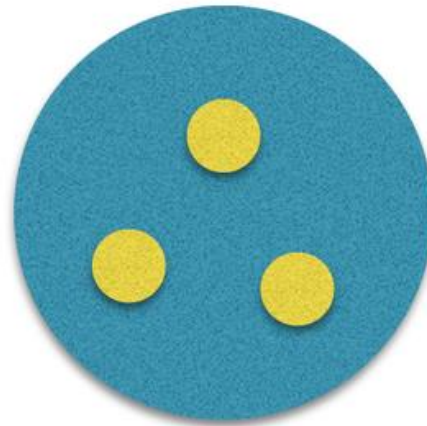
0.05% Ammonia
0.18% Sulphate
0.12% Phosphate
0.6% Chloride
0.01% Magnesium
0.015% Calcium
0.6% Potassium
0.1% Sodium
0.1% Creatinine
0.03% Uric acid
2% Urea

95% Water

Adsorption

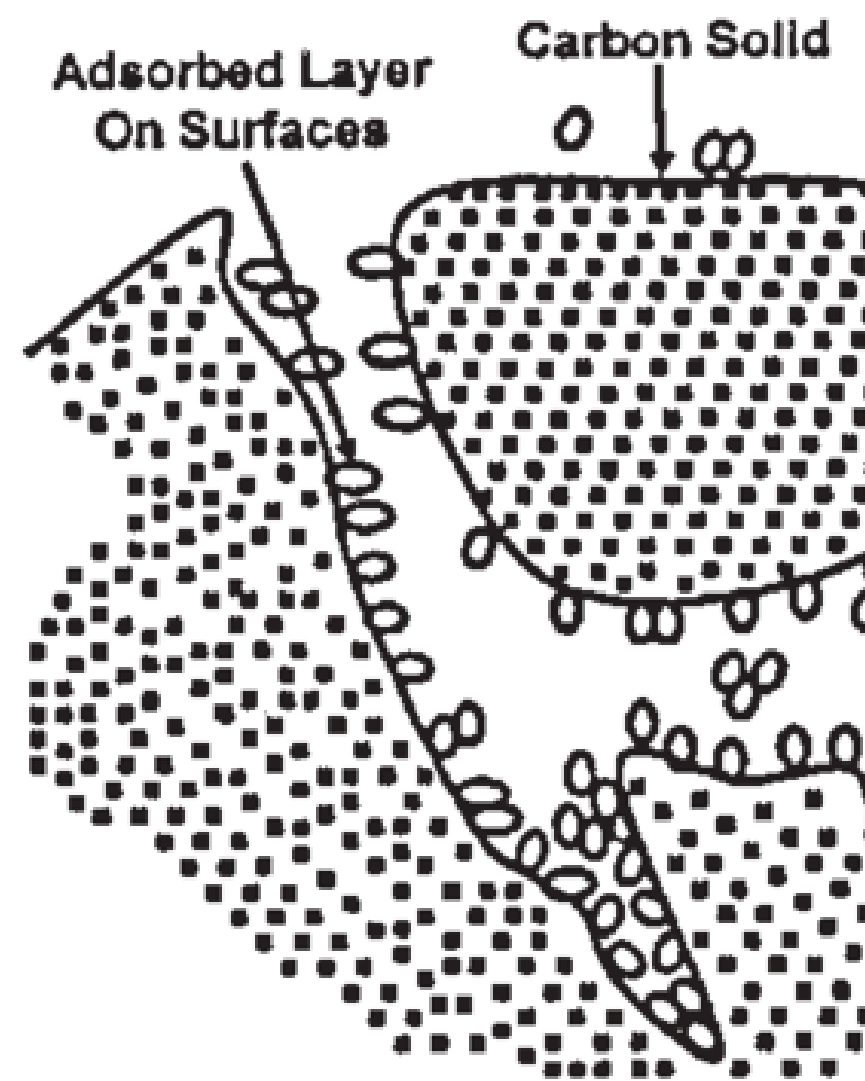
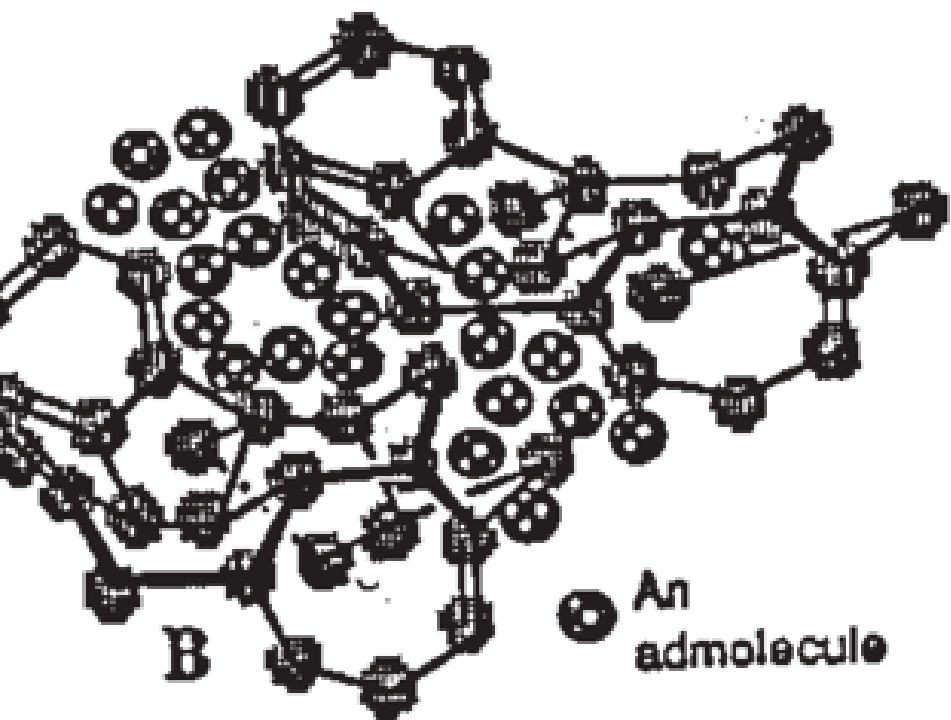
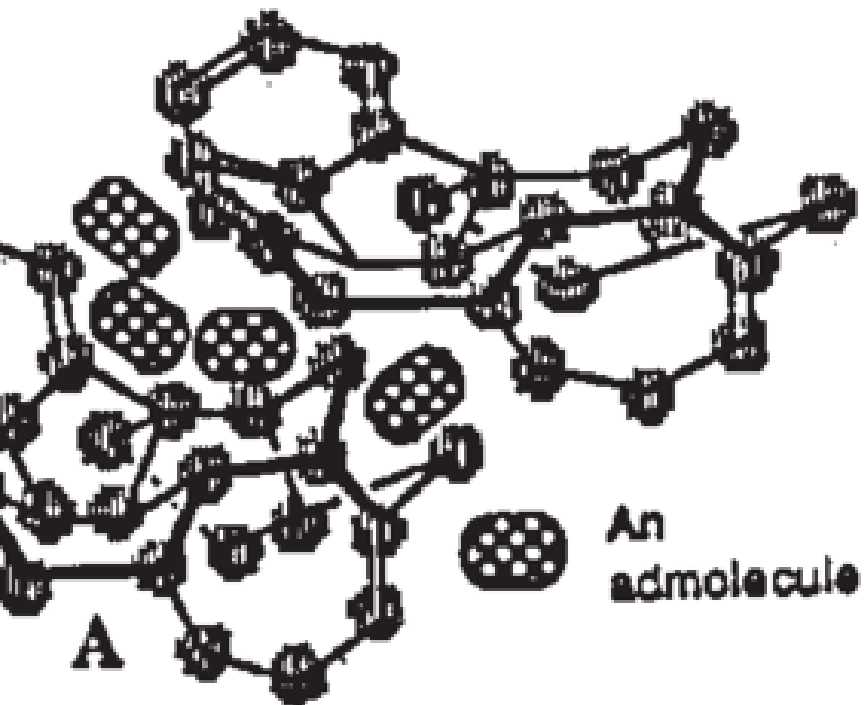


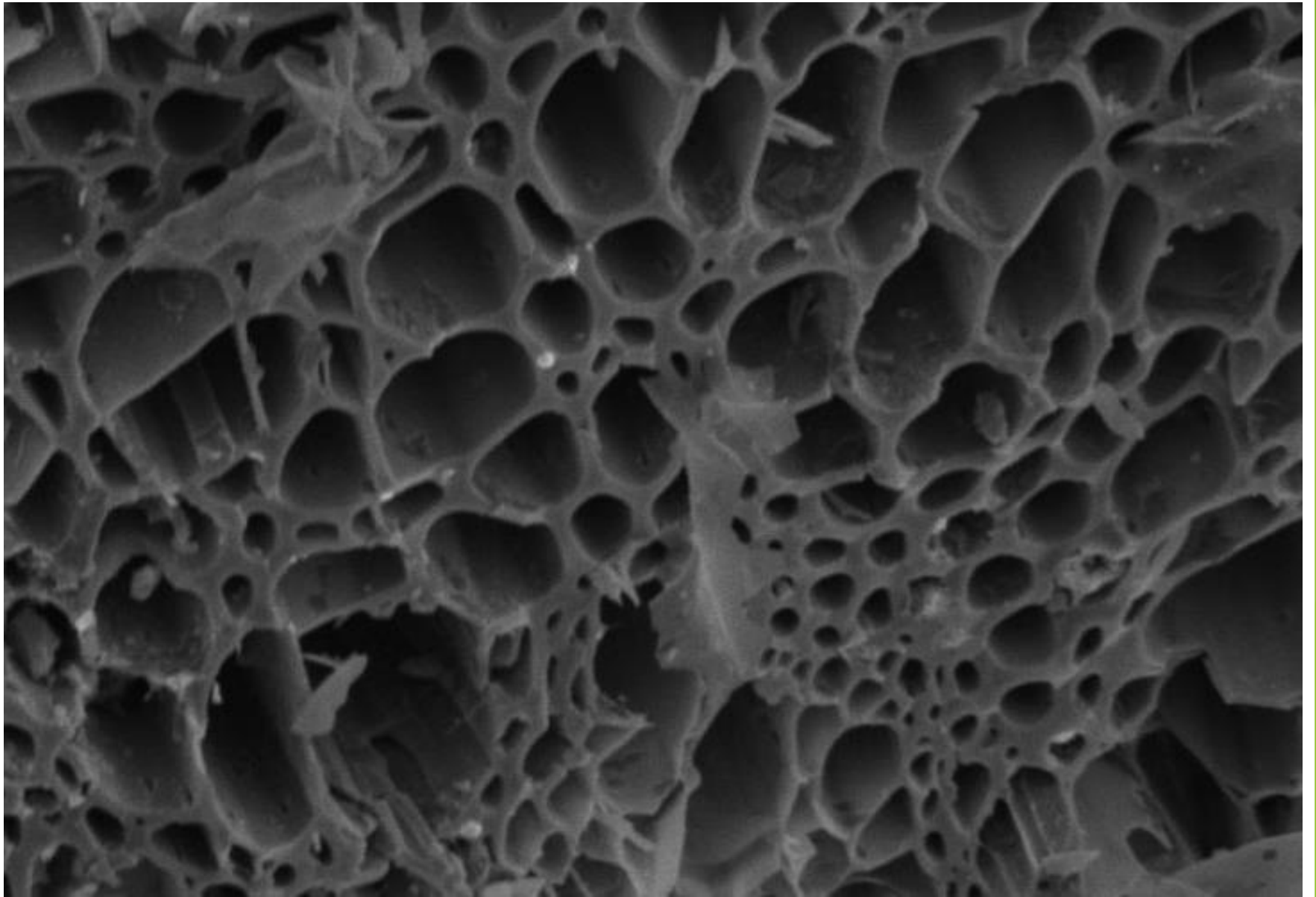
Absorption



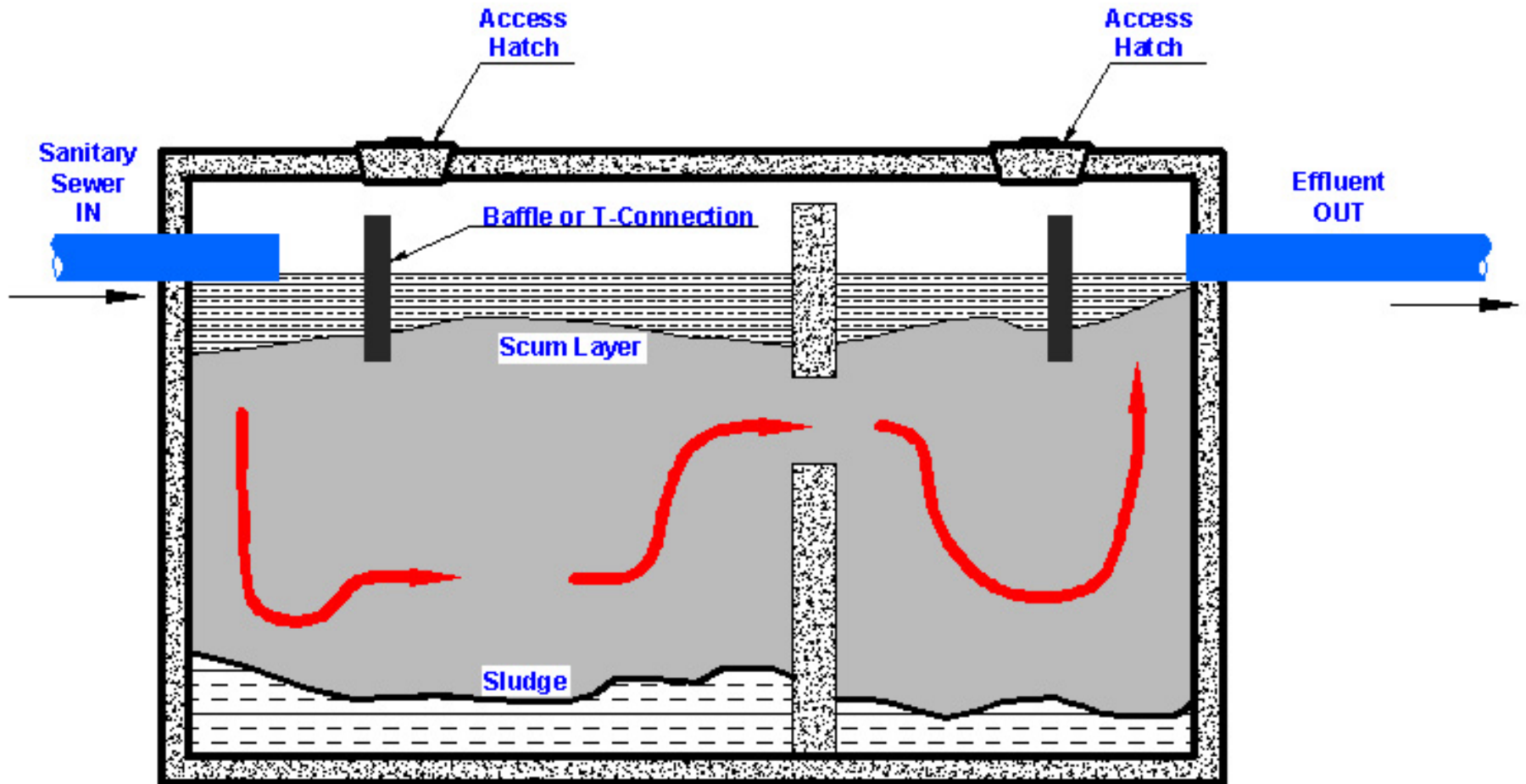
Adsorption/ Absorption

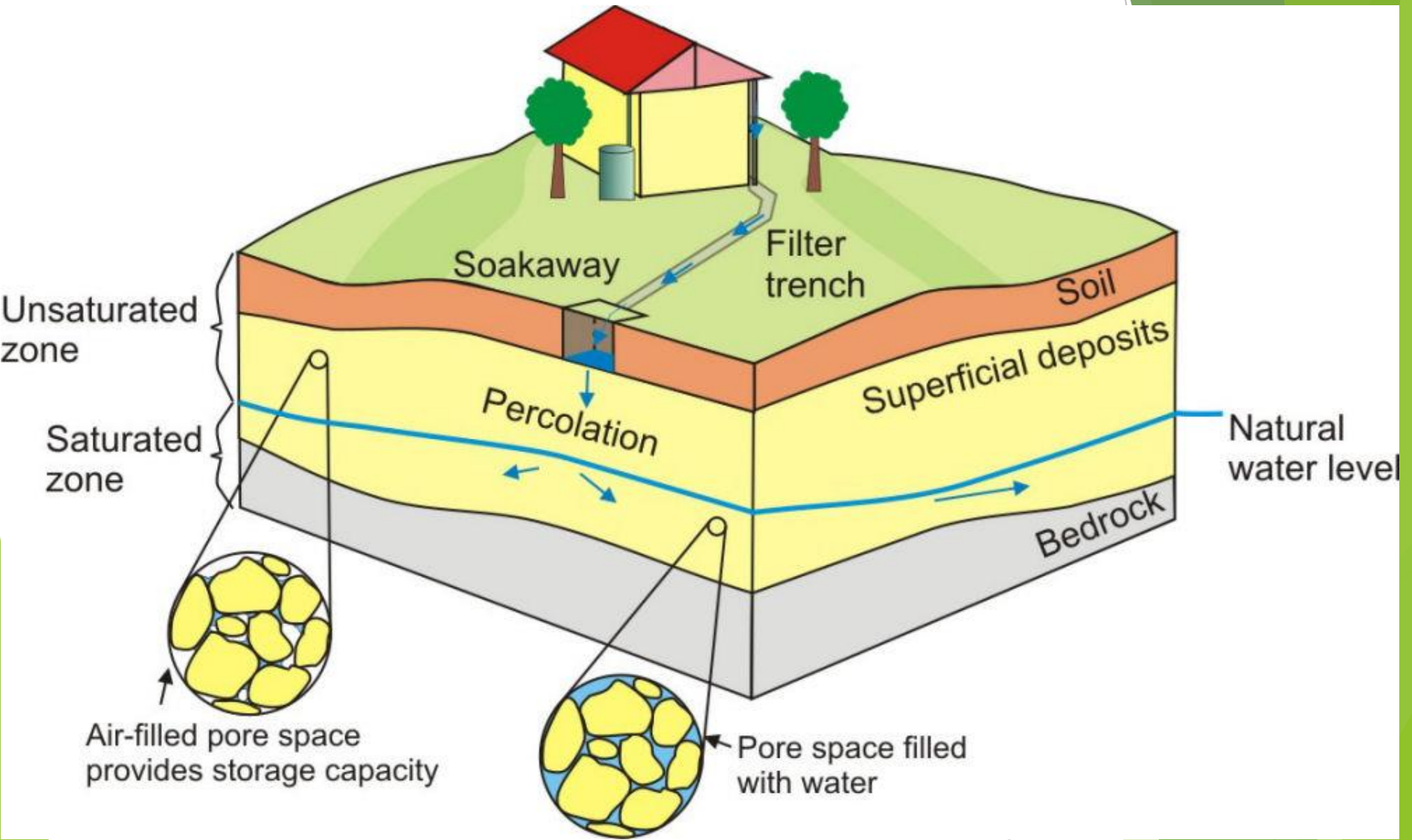






TYPICAL SEPTIC TANK





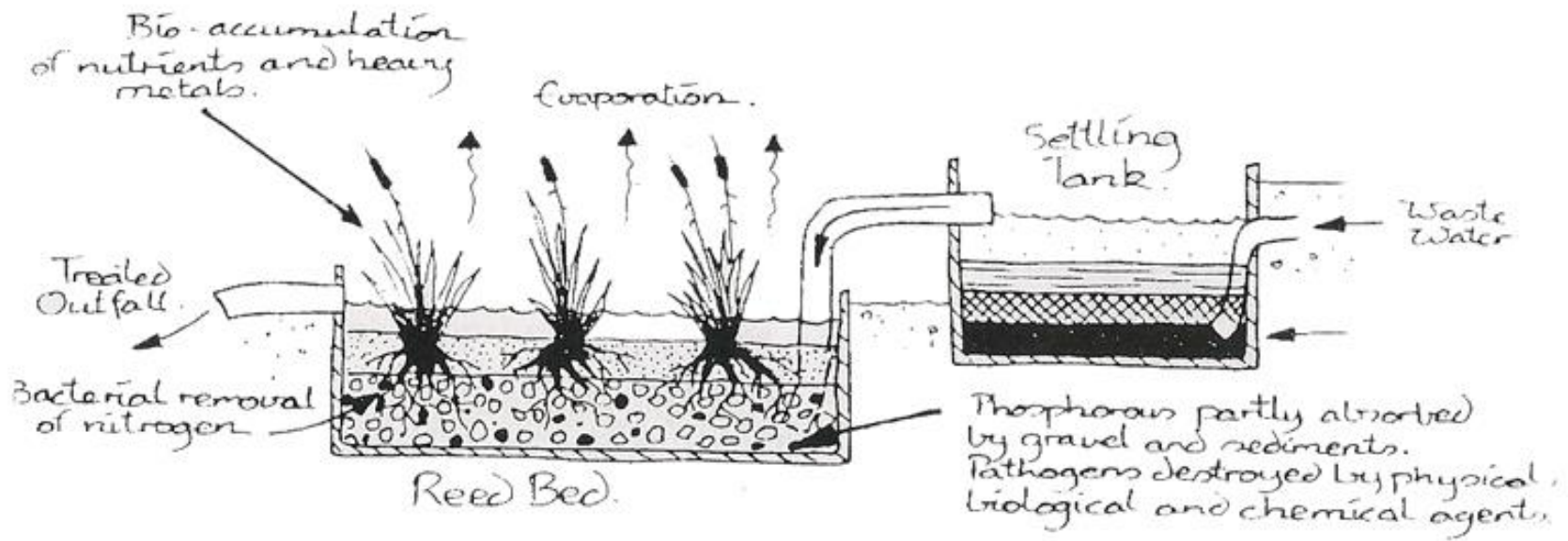
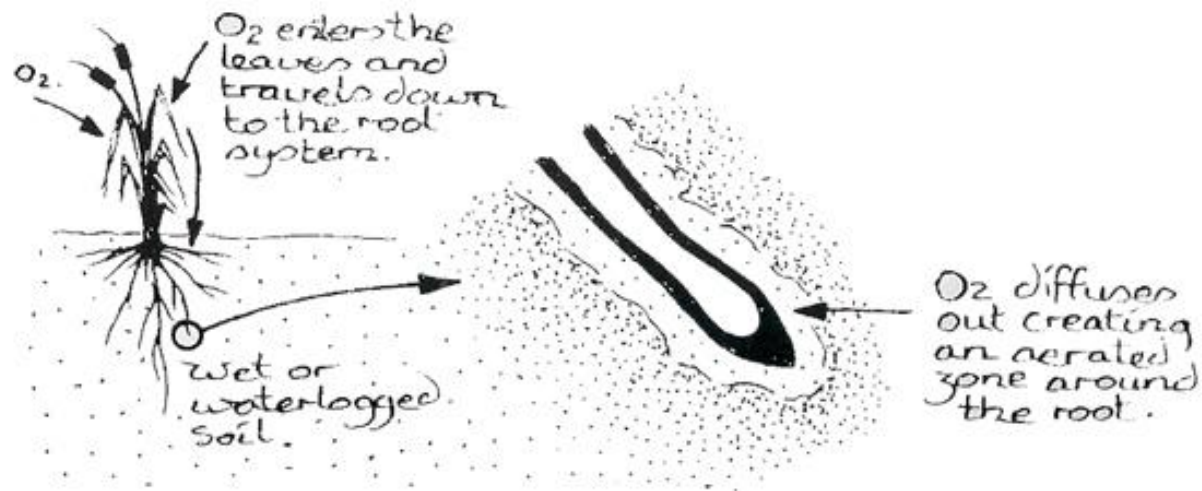


Figure 9.4 A typical reed bed system to treat and recycle your greywater.



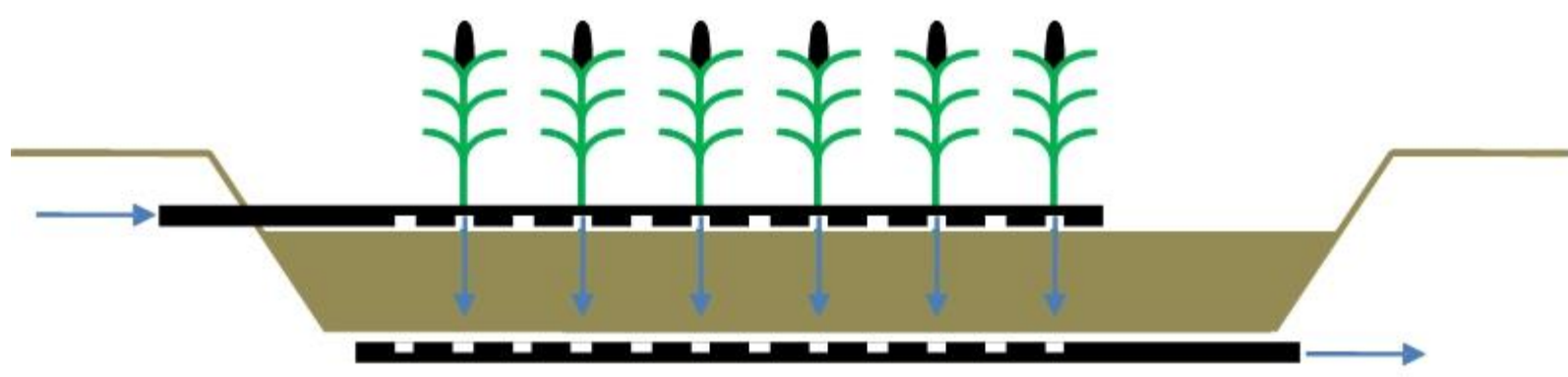
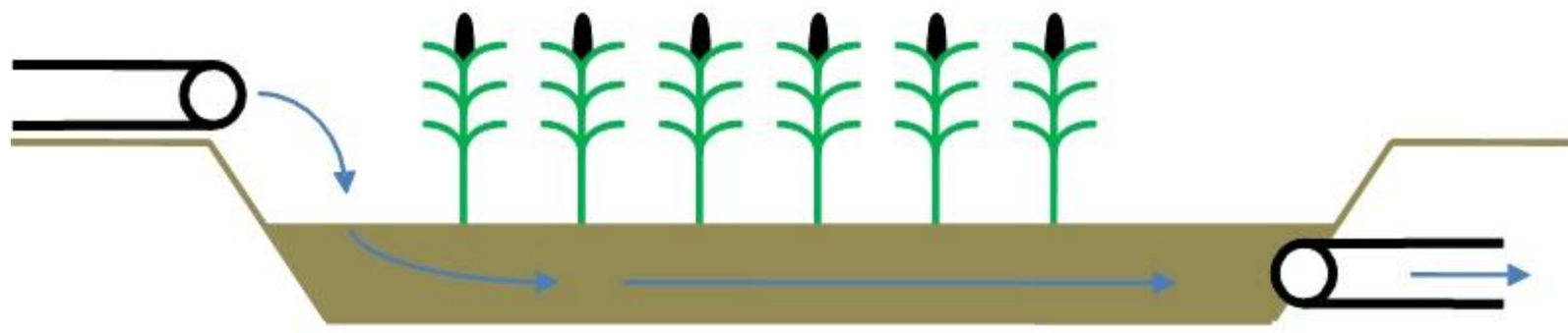
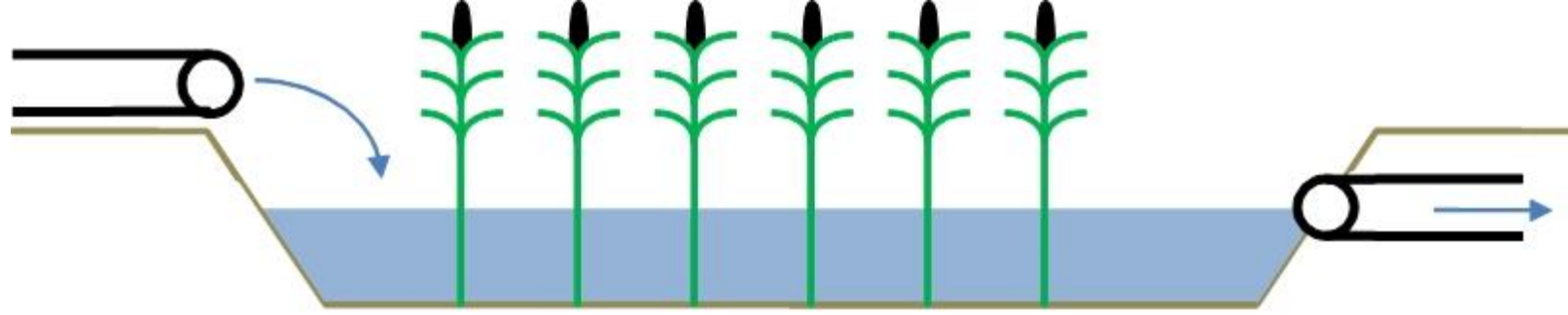
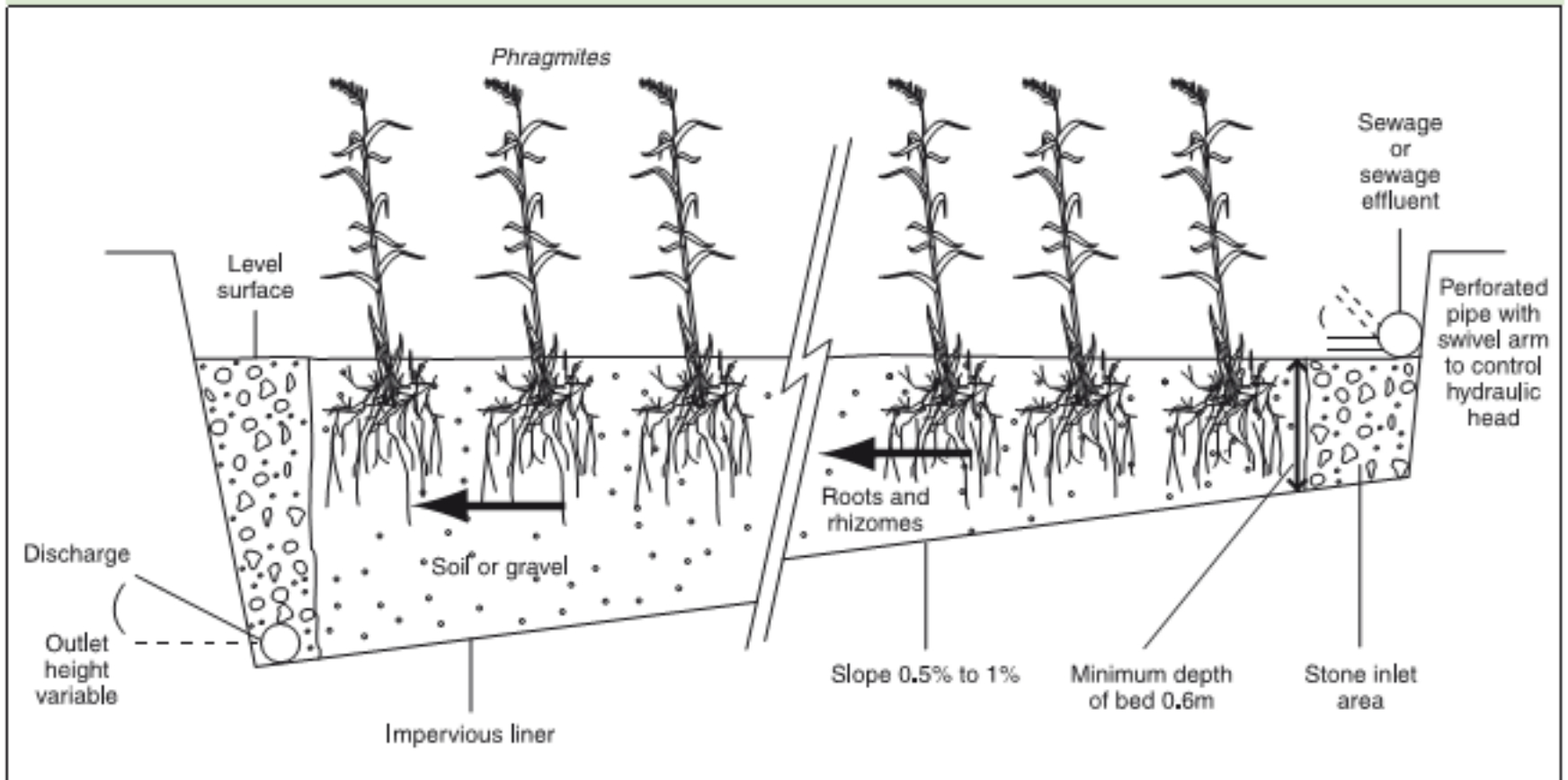


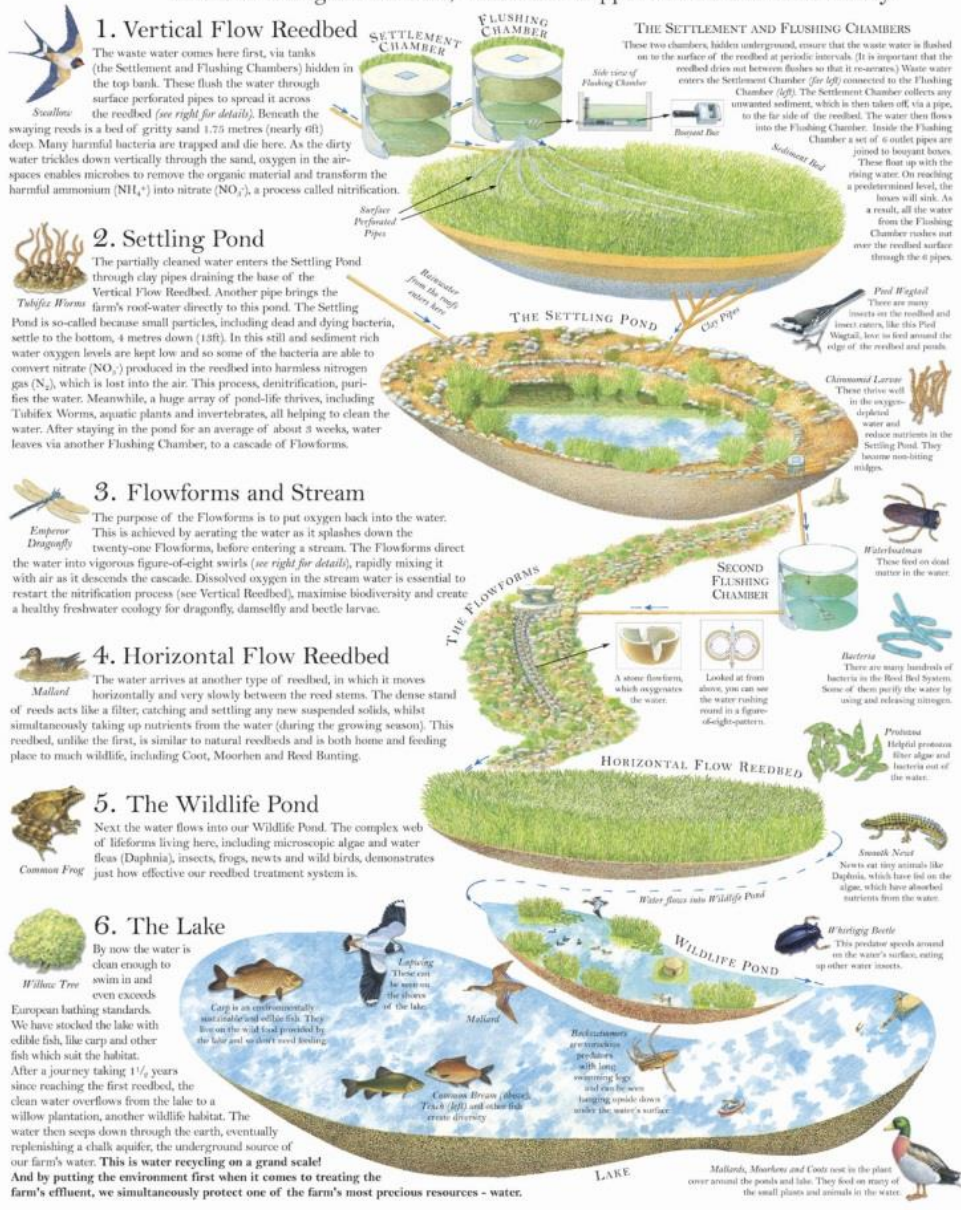
Diagram 3 Typical horizontal flow reed bed treatment system



The Reedbed System & How It Works

Our reedbed purification system treats all the waste water from the farm, chicken processing, the cottages and Eco Conference Centre. Using only natural processes to convert this waste water into clean water, the system needs no chemicals or power supply. Instead it relies entirely upon gravity to create a flow of water through a series of different ecological habitats, which also support enormous biodiversity.

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1. Vertical Flow Reedbed

The waste water comes here first, via tanks (the Settlement and Flushing Chambers) hidden in the top tank. These flush the water through surface perforated pipes to spread it across the reedbed (see right for details). Beneath the swaying reeds is a bed of gritty sand 1.75 metres (nearly 6ft) deep. Many harmful bacteria are trapped and die here. As the dirty water trickles down vertically through the sand, oxygen in the air-spaces enables microbes to remove the organic material and transform the harmful ammonium (NH₄⁺) into nitrate (NO₃⁻), a process called nitrification.



THE SETTLEMENT AND FLUSHING CHAMBERS

These two chambers, hidden underground, ensure that the waste water is flushed on to the surface of the reedbed at periodic intervals. (It is important that the reedbed dries out between flushes so that it re-aerates.) Waste water enters the Settlement Chamber (for left) connected to the Flushing Chamber (right). The Settlement Chamber collects any unwanted sediment, which is then taken off, via a pipe, to the far side of the reedbed. The water then flows into the Flushing Chamber. Inside the Flushing Chamber a set of 6 outlet pipes are joined to buoyant boxes. These float up with the rising water. On reaching a predetermined level, the boxes will sink. As a result, all the water from the Flushing Chamber rushes out over the reedbed surface through the 6 pipes.

2. Settling Pond

The partially cleaned water enters the Settling Pond through clay pipes draining the base of the Vertical Flow Reedbed. Another pipe brings the farm's roof-water directly to this pond. The Settling Pond is so-called because small particles, including dead and dying bacteria, settle to the bottom, a metres down (1.8ft). In this still and sediment rich water oxygen levels are kept low and so some of the bacteria are able to convert nitrate (NO₃⁻) produced in the reedbed into harmless nitrogen gas (N₂), which is lost into the air. This process, denitrification, purifies the water. Meanwhile, a huge array of pond-life thrives, including Tubific Worms, aquatic plants and invertebrates, all helping to clean the water. After staying in the pond for an average of about 3 weeks, water leaves via another Flushing Chamber, to a cascade of Flowforms.



THE SETTLING POND

Pool Wagtail
There are many insects on the reedbed and lower corners, like this Pool Wagtail, but it finds around the edge of the reedbed and ponds.

Chironomid Larvae
These thrive well in the oxygen-depleted water and reduce nutrients in the Settling Pond. They become non-biting midges.

3. Flowforms and Stream

The purpose of the Flowforms is to put oxygen back into the water. This is achieved by aerating the water as it splashes down the twenty-one Flowforms, before entering a stream. The Flowforms direct the water into vigorous figure-of-eight swirls (see right for details), rapidly mixing it with air as it descends the cascade. Dissolved oxygen in the stream water is essential to restart the nitrification process (see Vertical Reedbed), maximise biodiversity and create a healthy freshwater ecology for dragonfly, damselfly and beetle larvae.



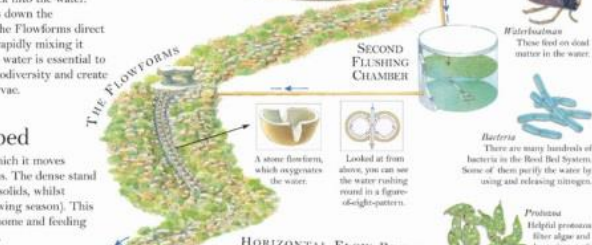
THE FLOWFORMS

Waterboatman
These feed on dead matter in the water.

Bacteria
There are many hundreds of bacteria in the Red Bed System. Some of them purify the water by using and releasing oxygen.

4. Horizontal Flow Reedbed

The water arrives at another type of reedbed, in which it moves horizontally and very slowly between the reed stems. The dense stand of reeds acts like a filter, catching and settling any new suspended solids, whilst simultaneously taking up nutrients from the water (during the growing season). This reedbed, unlike the first, is similar to natural reedbeds and is both home and feeding place to much wildlife, including Coot, Moorhen and Reed Bunting.



HORIZONTAL FLOW REEDBED

Protonema
Helpful protonema filter algae and bacteria out of the water.

Smooth Newt
Newts are tiny animals like Daphnia, which have fed on the algae, which have absorbed nutrients from the water.

5. The Wildlife Pond

Next the water flows into our Wildlife Pond. The complex web of lifeforms living here, including microscopic algae and water fleas (Daphnia), insects, frogs, newts and wild birds, demonstrates just how effective our reedbed treatment system is.

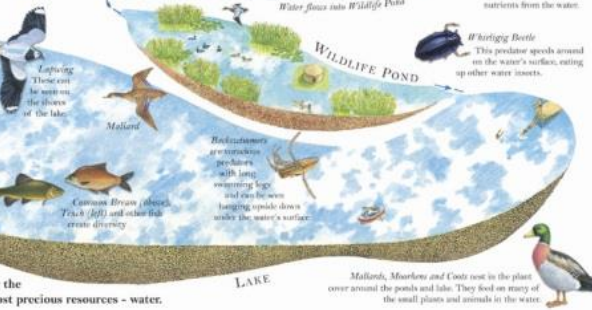


WILDLIFE POND

Water Boatman
This predator specks around on the water's surface, eating up other water insects.

6. The Lake

By now the water is clean enough to swim in and even exceeds European bathing standards. We have stocked the lake with edible fish, like carp and other fish which suit the habitat. After a journey taking 1 1/2 years since reaching the first reedbed, the clean water overflows from the lake to a willow plantation, another wildlife habitat. The water then seeps down through the earth, eventually replenishing a chalk aquifer, the underground source of our farm's water. This is water recycling on a grand scale! And by putting the environment first when it comes to treating the farm's effluent, we simultaneously protect one of the farm's most precious resources - water.



LAKE

Mallards, Moorhens and Coots are in the plants cover around the ponds and lake. They feed on many of the small plants and animals in the water.



RESORTLE UNIT







phytoremediation

Phragmites sp.

ecosystem

Typhus sp.

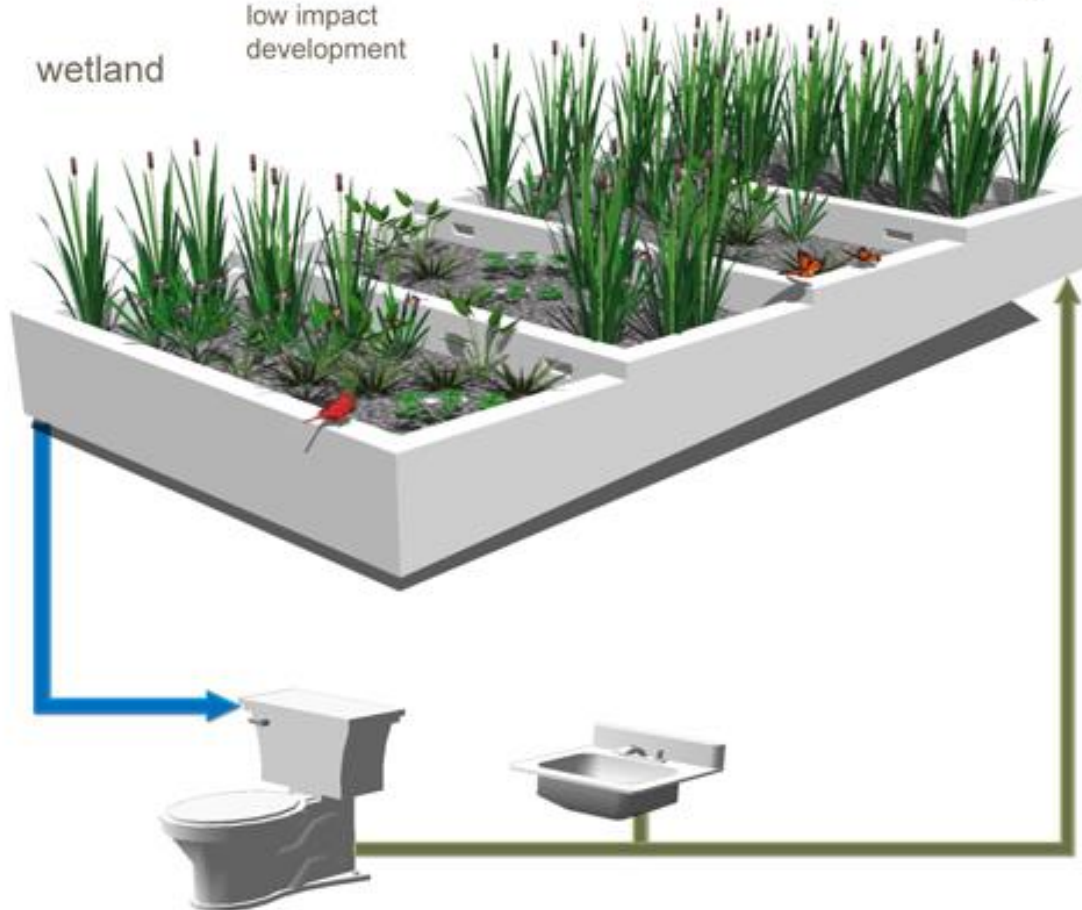
ROOFTOP REED BEDS

water reuse

efficiency

wetland

low impact development



Subsurface-flow reed beds are a proven **low energy** technology for the bio-chemical treatment of wastewater.

Rooftop installation provides storm water retention capacity, **reducing urban flooding.**

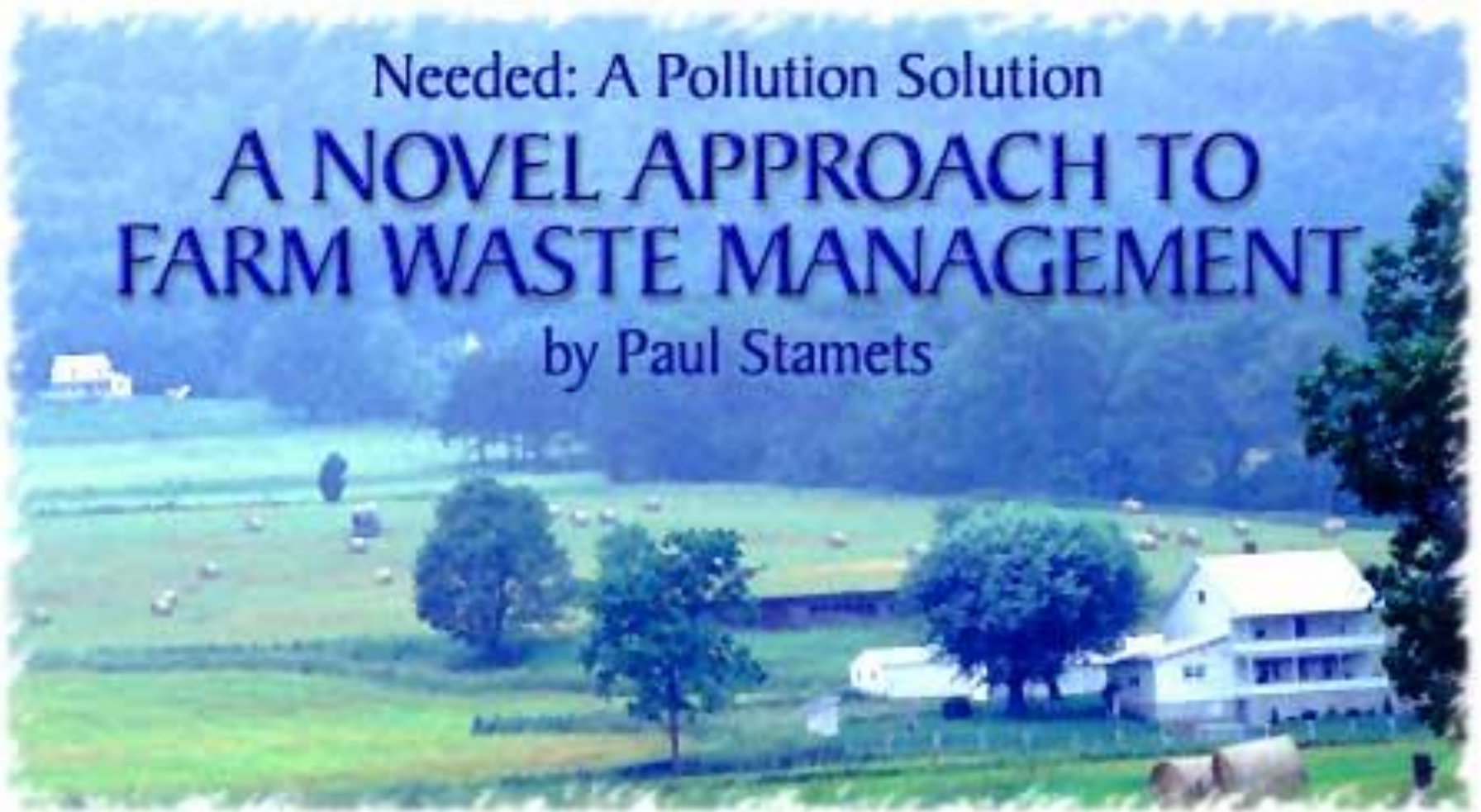
Evapotranspiration of the water, and the insulation effect of expanded aggregate provide thermal regulation within the building, **improving human comfort.**

A lack of exposed surface water, prevents mosquito larval growth, but the vegetation offers an alternative built habitat for **increasing local biodiversity.**

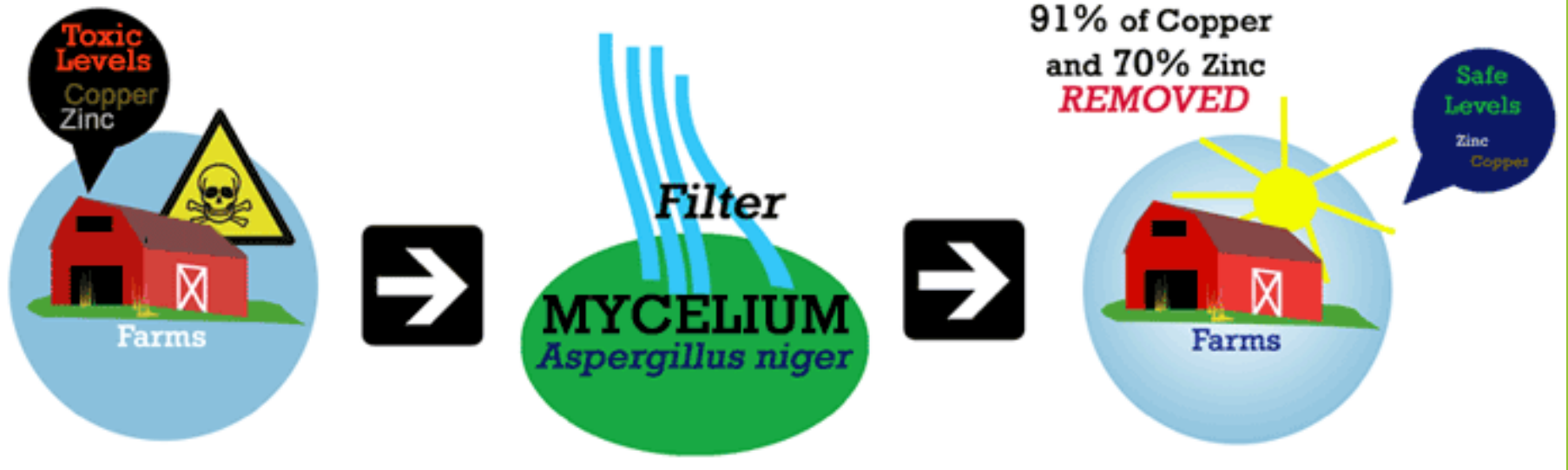
Needed: A Pollution Solution

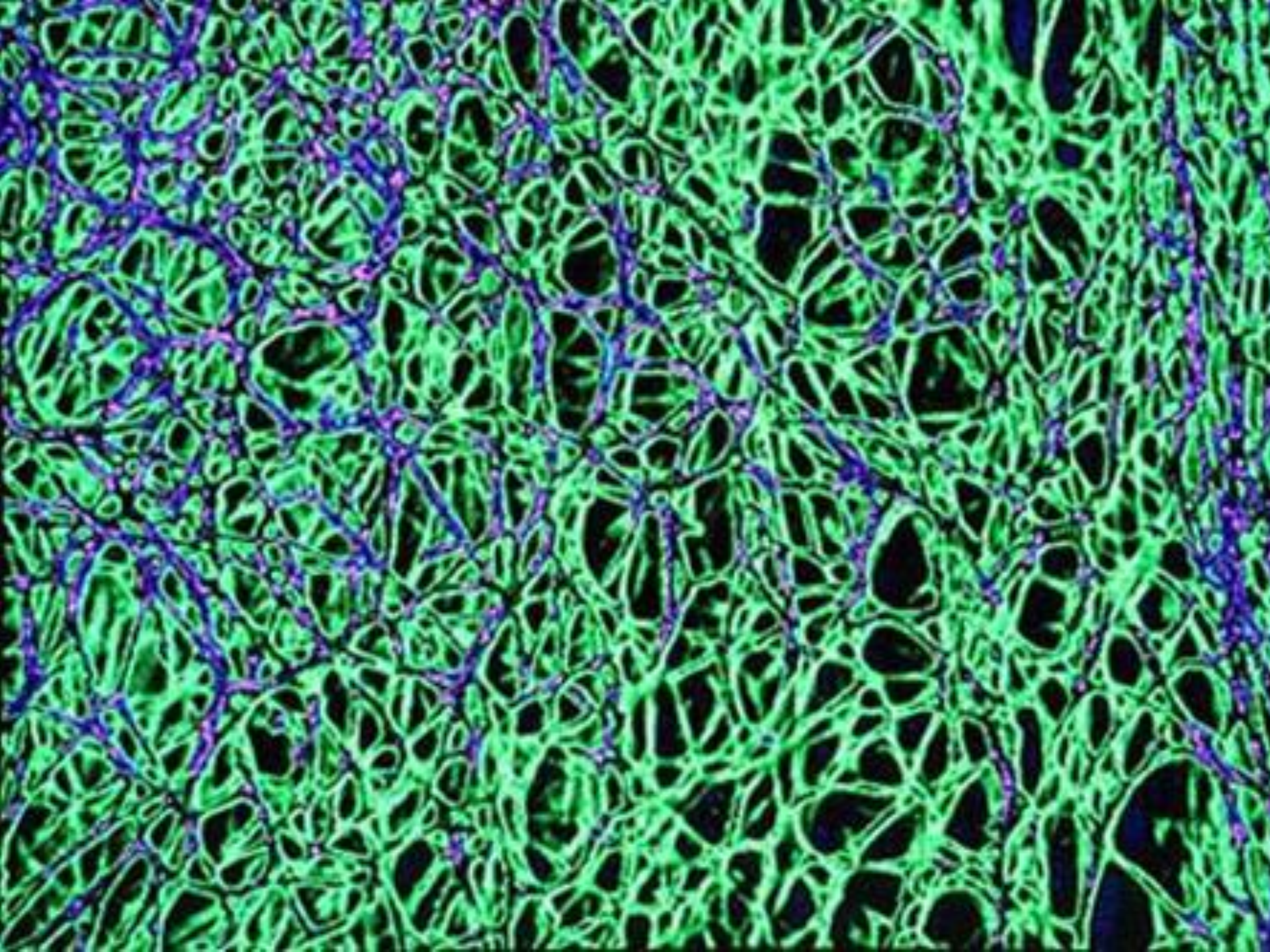
A NOVEL APPROACH TO FARM WASTE MANAGEMENT

by Paul Stamets



Micorfiltration



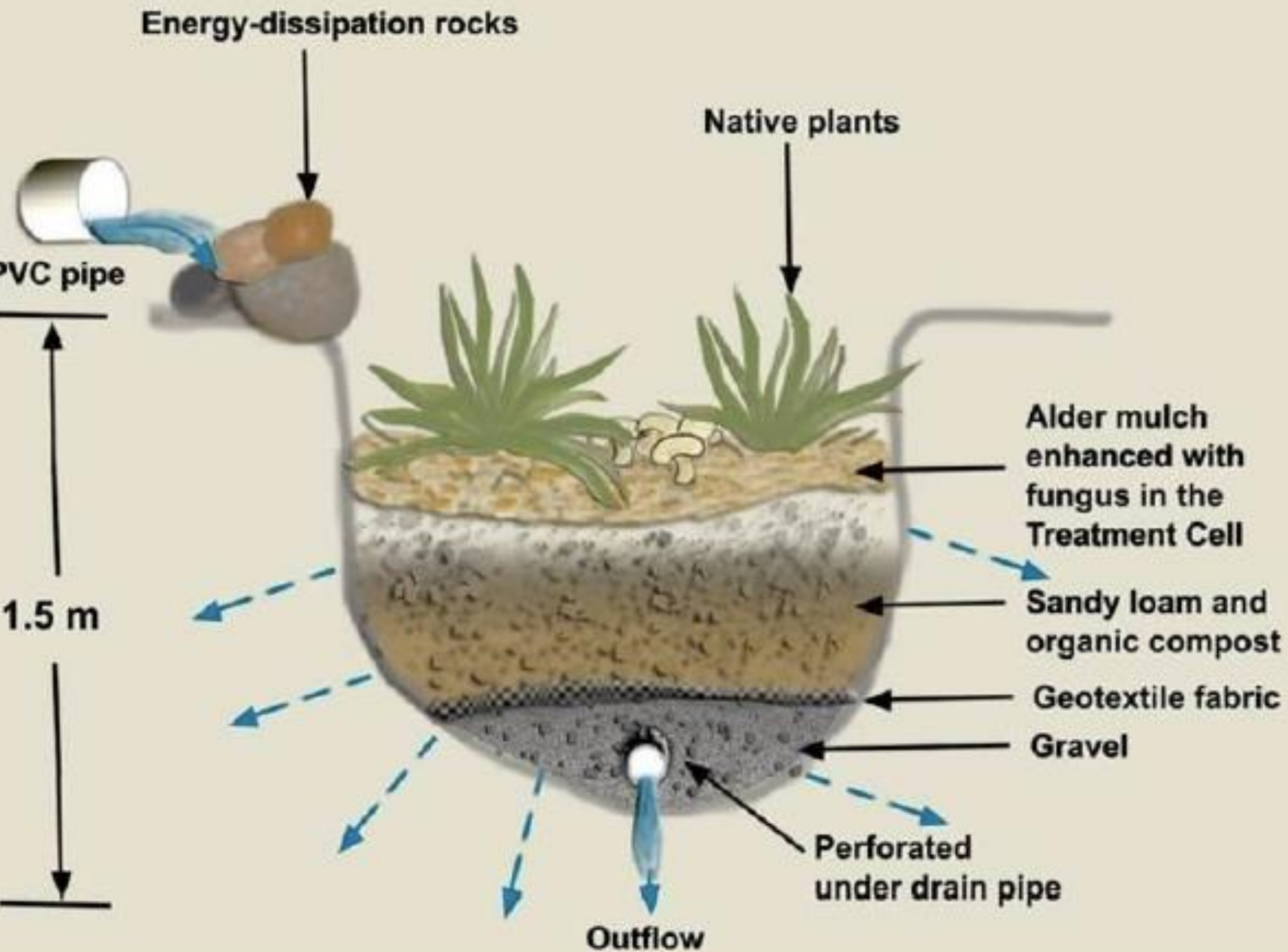




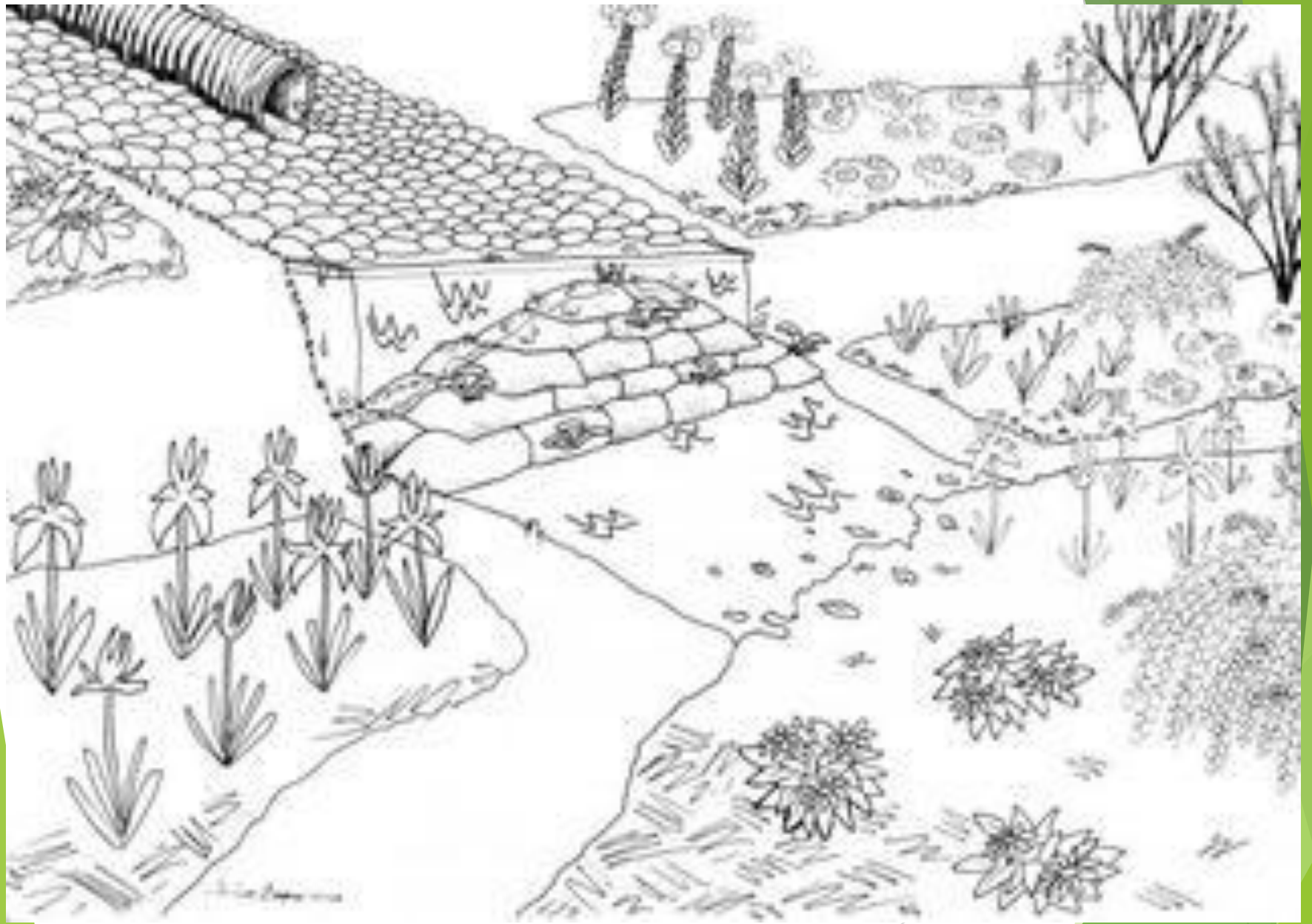
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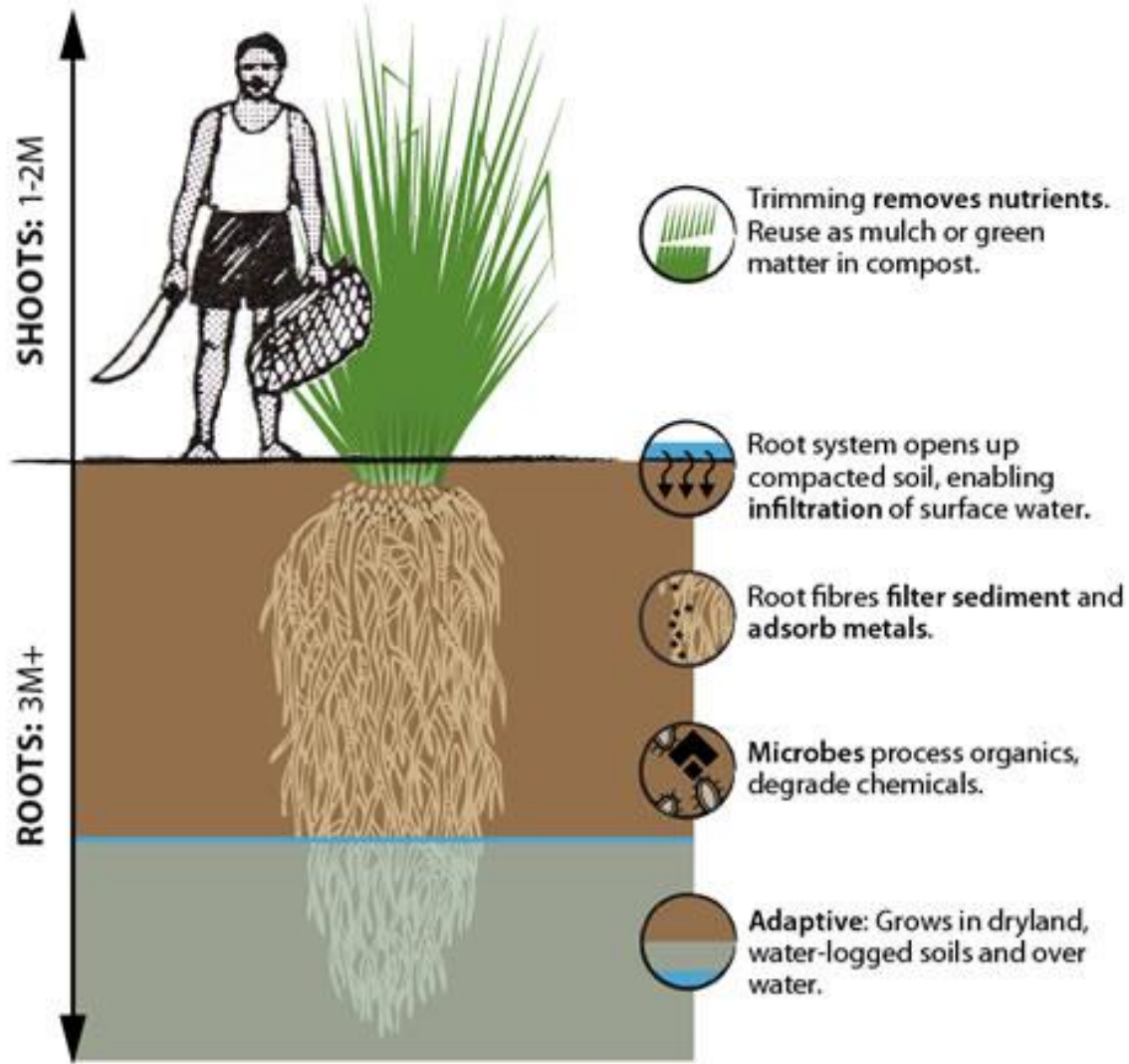


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VETIVER PHYTOREMEDIATION: WASTEWATER PROCESSING

Sources: *The Vetiver Network International*, tvni.org; *Phytoremediation: Technology Evaluation Report*, JL Schnoor, GWRTAC 1997.



Vietnam



Water treatment in Vietnam

18 16 18

With high capacity of removing N and P in polluted water, vetiver cleaned up blue green algae in 4 days



Same effluent after 4 days
with vetiver, rec
6mg/L (94%) and P to
1mg/L (90%)

Vetiver removes N and P

Sewage effluent infested with B-G
N = 100mg/L and
P = 10mg/L

8-12-00