WATER POLLUTION

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WATER POLLUTION

Water pollution is the contamination of water bodies (e.g. lakes, rivers, oceans and ground waters).

Water pollution occurs when pollutants are discharged directly or indirectly into water bodies without adequate treatment to remove harmful compounds.

Water pollution affects plants and organisms living in these bodies of water.

In almost all cases the effect is damaging not only to individual species and populations, but also to the natural biological communities.

The coast of the Philippines depicts water pollution, a problem affecting most of the world in one form or another.

WATER POLLUTION

Raw sewage and industrial waste flows across international borders – New River passes from Mexico to California, USA.

Water pollution

Water pollution is a major global problem which requires ongoing evaluation and revision of water resource policy at all levels (international level down to individual aquifers and wells).

It has been suggested that it is the leading worldwide cause of deaths and diseases, and that it accounts for the deaths of more than 14,000 people daily.

An estimated 700 million Indians have no access to a proper toilet, and 1,000 Indian children die of diarrheal sickness every day.

Some 90 % of China's cities suffer from some degree of water pollution, and nearly 500 million people lack access to safe drinking water.

In addition to the acute problems of water pollution in developing countries, industrialized countries, continue to struggle with pollution problems as well.

In the most recent national report on water quality in the USA, 45 % of assessed stream km, 47 % of assessed lake ha, and 32 % of assessed bay and estuarine square km were classified as polluted.

Water is typically referred to as polluted when it is impaired by anthropogenic contaminants and either does not support a human use, such as drinking water.

Natural phenomena such as volcanoes, algae blooms, storms and earthquakes also cause major changes in water quality and the ecological status of water.

WATER POLLUTION

Millions depend on the polluted Ganges river

The Water Framework Directive

(Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy)

This EU directive commits EU member states to achieve good qualitative and quantitative status of all water bodies (including marine waters up to one nautical mile from shore) by 2015.

The directive defines "surface water status" as the general expression of the status of a body of surface water, determined by the poorer of its ecological status and its chemical status.

Thus, to achieve "good surface water status" both the ecological status and the chemical status of a surface water body need to be at least "good".

Ecological status refers to the quality of the structure and functioning of aquatic ecosystems of the surface waters.

Water Framework Directive

Water is an important facet of all life and the water framework directive sets standards which ensure the safe access of this resource.
The Directive requires the production of a number of key documents over six year planning cycles.
Most important among these is the **River Basin Management Plans**, to be published in 2009, 2015 and 2021. Draft River Basin Management Plans are published for consultation at least one year prior.
Good ecological status is defined locally as being lower than a theoretical reference point of pristine conditions, i.e. in the **absence of anthropogenic influence**.
Article 14 of the directive requires member states "to encourage the active involvement of interested parties" in the implementation of the directive.

This is generally acknowledged to be an assimilation of the Aarhus Convention.

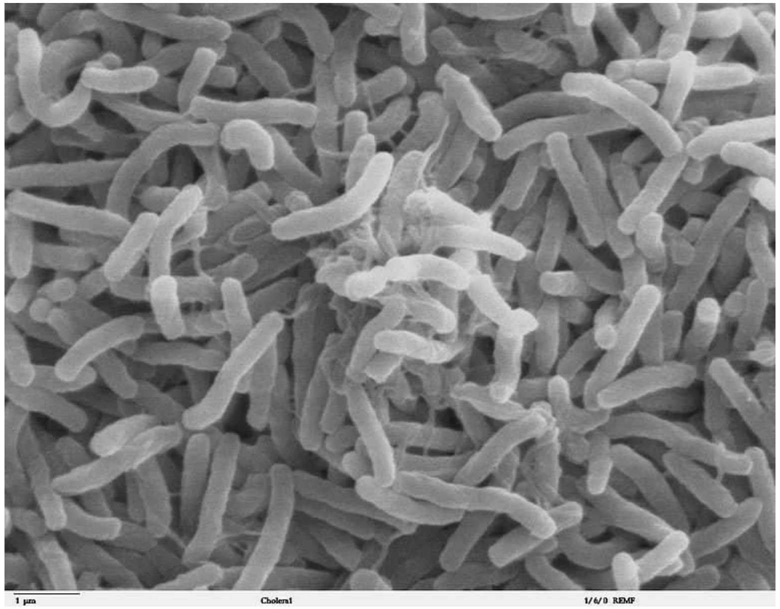
WATER POLLUTION AND MORBIDITY

Link between water pollution and morbidity (saslimstība) has been equipollent stated due to cholera epidemic in London, 1854.

Transmission is primarily due to the faeces contamination of food and water due to poor sanitation. This bacterium can, however, live naturally in any environment.

The **Haiti cholera outbreak** began in late October 2010 in the rural area of Haiti about 100 kilometres north of the capital, Port-au-Prince, killing 4,672 people by March 2011 and hospitalising thousands more.
The outbreak followed a powerful earthquake which devastated the country on 12 January 2010.
By March 2011, 252,640 cases had been reported. By the first 10 weeks of the epidemic, cholera spread to all of Haiti's 10 departments or provinces.

HAITI CHOLERA OUTBREAK



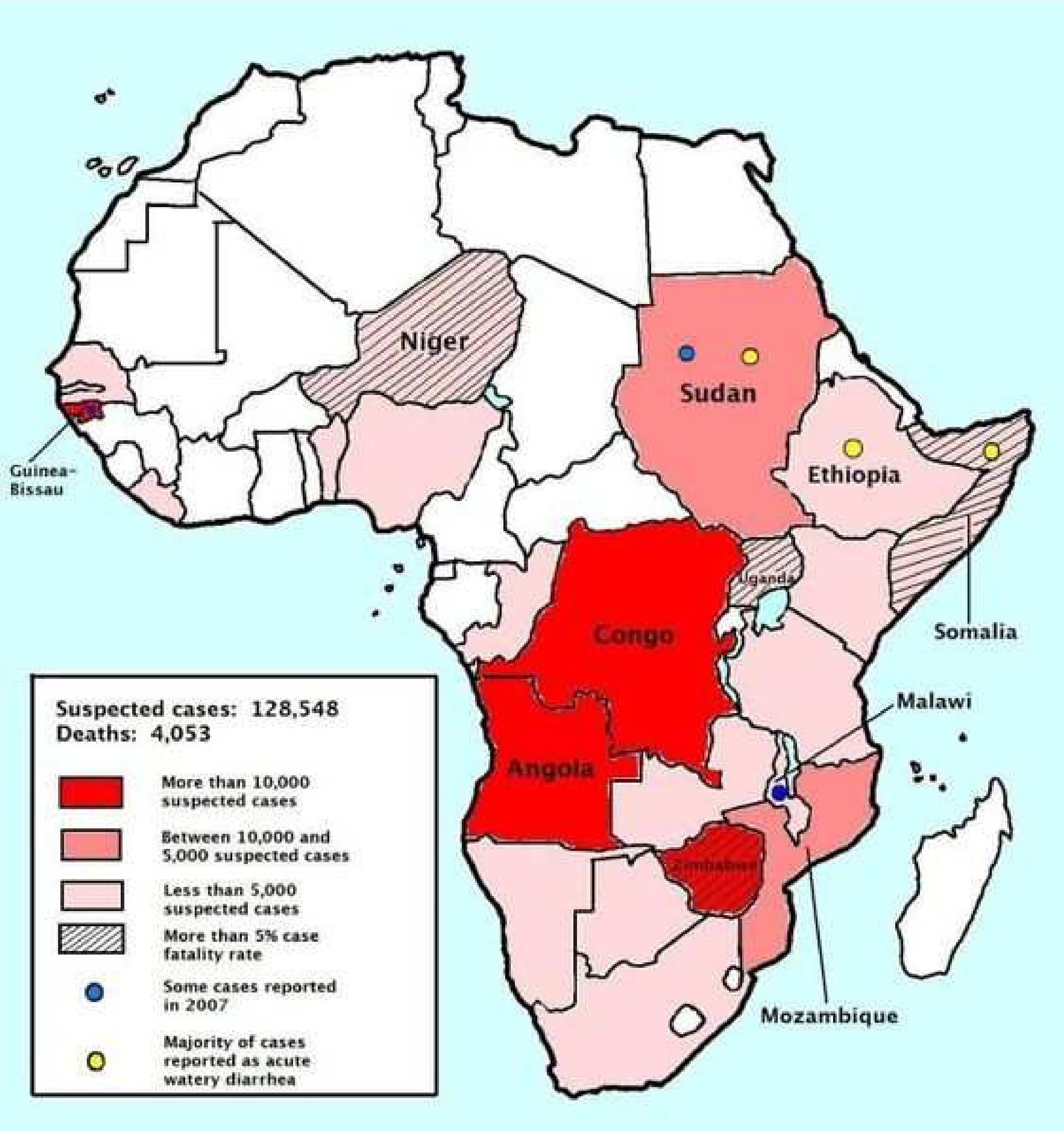
Earthquake in the Haiti - 12.01.2010.

Image of *Vibrio cholerae*

In November 2010, the first cases of cholera were reported in the Dominican Republic and a single case in Florida, US.
As of late September, 2011, some 6,435 deaths have been reported and is expected to continue rising.

Patients of cholera in Haiti

CHOLERA EPIDEMIC IN AFRICA



Map of the 2008–2009 cholera outbreak in sub-Saharan Africa showing the statistics as of 12 February 2009.

NEED FOR WATER RESOURCES PROTECTION

Health protection is primary reason for environmental control in the whole world.

Other reasons :

- Protection of water resources
- Conservation of fishing zones
- Development of recreational areas

CATEGORIES OT THE WASTWATER

Surface water and groundwater have often been studied and managed as separate resources, although they are interrelated.

Surface water seeps through the soil and becomes groundwater.

Conversely, groundwater can also feed surface water sources.

Sources of surface water pollution are generally grouped into two categories based on their origin.

Point source water pollution refers to contaminants that enter a waterway from a single, identifiable source, such as a pipe or ditch.

Examples of sources in this category include discharges from a sewage treatment plant, a factory, or a city storm drain.

Non-point source (NPS) pollution refers to diffuse contamination that does not originate from a single discrete source. NPS pollution is often the cumulative effect of small amounts of contaminants gathered from a large area.

A common example is the leaching out of nitrogen compounds from fertilized agricultural lands. Nutrient runoff in storm water from "sheet flow" over an agricultural or a forest are also cited as examples of NPS pollution.

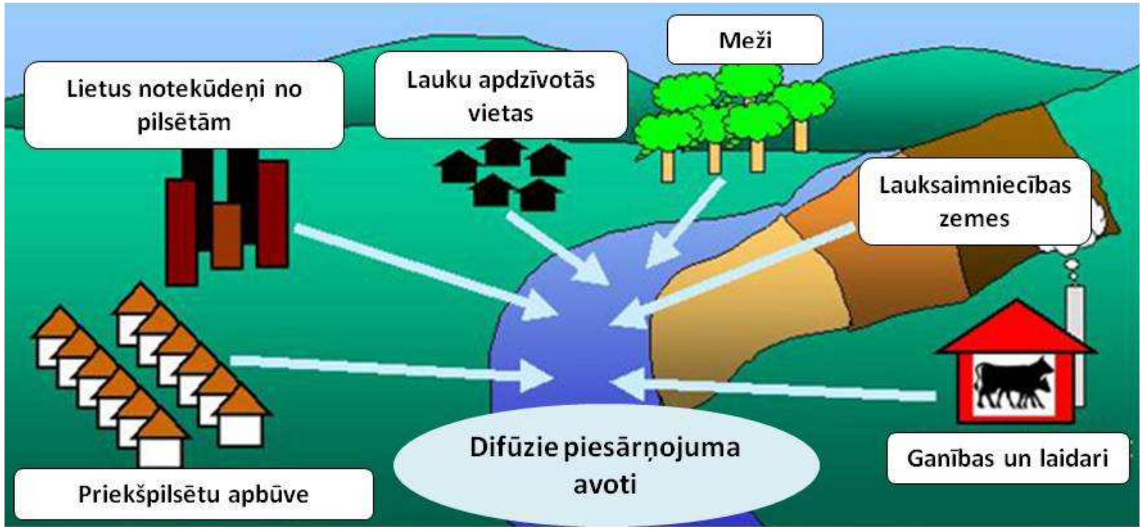
Contaminated **storm water** washed off of parking lots, roads and highways, called urban runoff, is sometimes included under the category of NPS pollution. However, this runoff is typically channelled into storm drain systems and discharged through pipes to local surface waters, and is a point source.

However where such water is not channelled and drains directly to ground it is a non-point source.

CATEGORIES OT THE WASTWATER

Point source water pollution
Pollution enter a waterway (river, lake) from a single, identifiable source (pipe, ditch).

Non-point source pollution
Pollution does not originate from a single source. Pollution is often the cumulative effect of small amounts of contaminants gathered from a large area.



POINT SOURCE POLLUTION

Point source pollution – shipyard - Rio de Janeiro

CONTAMINANTS OF WATER

The specific contaminants leading to pollution in water include a **wide spectrum** of chemicals, pathogens, and physical or sensory changes such as elevated temperature and discoloration. While many of the chemicals and substances that are regulated may be **naturally occurring** (calcium, sodium, iron, manganese, etc.) the concentration is often the key in determining what is a natural component of water, and what is a contaminant.

High concentrations of naturally-occurring substances can have negative impacts on aquatic flora and fauna.

Oxygen-depleting substances may be natural materials, such as plant matter (e.g. leaves and grass) as well as man-made chemicals. Other natural and anthropogenic substances may cause turbidity (cloudiness) which blocks light and disrupts plant growth, and clogs the gills (žaunas) of some fish species.

Many of the chemical substances are **toxic**. Pathogens can produce waterborne diseases in either human or animal hosts. Alteration of water's physical chemistry includes acidity (change in pH), electric conductivity, temperature, and eutrophication.

Eutrophication is an increase in the concentration of chemical nutrients in an ecosystem to an extent that increases in the primary productivity of the ecosystem. Depending on the degree of eutrophication, subsequent negative environmental effects such as anoxia (oxygen depletion) and severe reductions in water quality may occur, affecting fish and other animal populations.

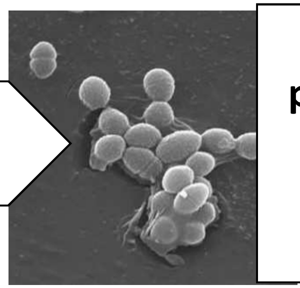
Muddy river polluted by sediment

A garbage collection boom in an urban-area stream in Auckland, New Zealand

WATER POLLUTANT GROUPS

1. **Oxygen-depleting substances : organic waste, used by aerobic microorganisms in presence of oxygen.**

Lot of organic waste



Huge populations of micro-organism

Bulky consumption of oxygen

Deficit of oxygen in water

2

If concentration of oxygen in water is insufficient, oxygen consumed living creations can go out.

Very important is to know what is the biochemical oxygen demand (BOD).

The BOD_5 value is most commonly expressed in milligrams of oxygen consumed per litre of sample during 5 days of incubation at 20 °C and is often used as a robust surrogate of the degree of organic pollution of water.

WATER POLLUTANT GROUPS

2. **Water soluble inorganic substances**: salts, acids, compounds of heavy metals. Acidity caused by industrial discharges (especially sulphur dioxide from power plants). Presence in soil (via polluted water) of these substances reduce agricultural harvest, as well as to arouse corrosion of the metals.

3. **Inorganic nutrients for plants**: water soluble nitrates, phosphates, which are promoters of eutrophication. Ammonia from food processing waste.

4. **Organic substances** : oil products, petrol, plastic, pesticides, solvents, detergents, *etc.*

In surface and ground waters of developed countries are find at least **700 synthetic organic substances** – many of them might to bring on an kidney illness, hereditary defects, a number of cancer varieties.

WATER POLLUTANT GROUPS

5. Suspended substances: water non-soluble soil or mineral participles, other organic and inorganic substances**.**

These substances:

- cause turbidity,
- reduce water plants ability for photosynthesis,
- affect trophical chains,
- make difficulties for some species to find food,
- through sediments destroy feeding and spawn territories, as well as, fill bottom of rivers and lakes, change flow of rivers,
- absorb and transport bacteria, pesticides or other hazardous substances on the surface of solid participles.

6. Radioactive substances: water soluble radioisotopes can accumulate and move from one to another species in the trophical chains.

Ionized radiation of radioactive substances can induce hereditary defects, to bring on cancer illness and to damage genetic information.

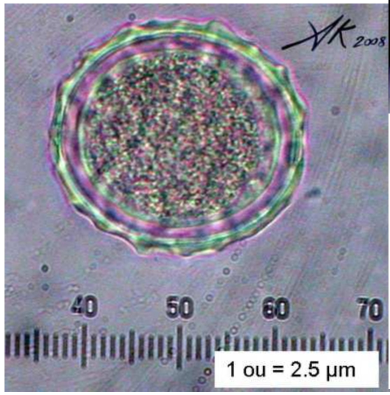
WATER POLLUTANT GROUPS

7. **Heat**: wormed water, as result of the cooling processes (thermo-electro plants) are flown into river or lake.

Temperature rising lowers solubility of oxygen in water and reduce concentration of oxygen in water. Wherewith water living species feel deficit of oxygen and become more sensitive against diseases, parasitic species and toxic chemicals.

8. **Pathogenic organisms**: microorganisms, parasitic worms.

Majority of microorganisms are not dangerous, but take part in processes of destruction of the organic substances. Unfortunately in waters, especially, in wastewaters, can be pathogenic microorganisms, which induce infection diseases.

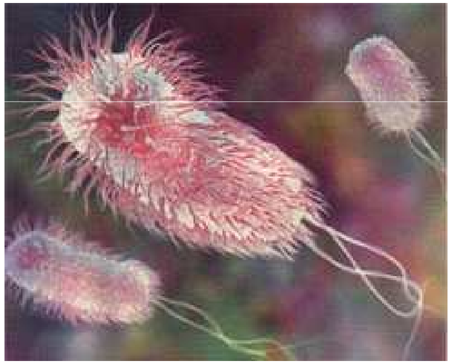


Ascaris lumbricoides (human worm) and its egg.

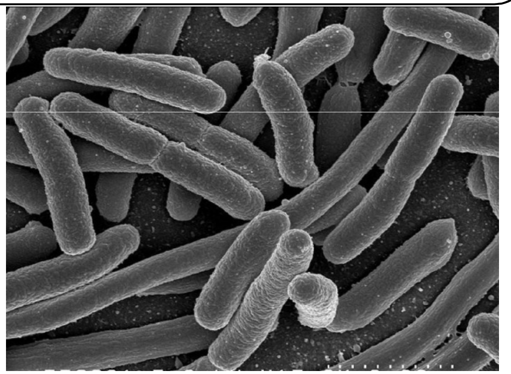
MICROORGANISMS IN WATER

Microorganisms and parasitic warms to get in water mainly from household wastewater.

Under constant wet and temperature conditions microorganisms fast multiply – accordingly household wastewater is ideal environment for microbes, primary bacteria, some viruses and protozoa existence.



Escherichia coli **bacteria under different magnification**



Analyses for detection of the pathogenic microorganisms are very complicated, therefore are used method don't search for individual pathogen species, but to carry out integral analyses, for example, to fix coli titre.

World Health Organisation recommend that in 100 ml drinking water don't be any *Escherichia coli* bacteria.

PATHOGENS

A manhole cover unable to contain a sanitary sewer overflow.

Microorganisms sometimes found in surface waters which have caused human health problems include:

- *Burkholderia pseudomallei*
- *Cryptosporidium,*
- *Giardia lamblia,*
- *Salmonella,*
- *Novovirus and other viruses,*
- *Parasitic worms (helminths).*

High levels of pathogens may result from inadequately treated sewage discharges.

In developed countries, older cities with aging infrastructure may have leaky sewage collection systems (pipes, pumps, valves), which can cause sanitary sewer overflows.

Pathogen discharges may also be caused by poorly managed livestock operations.

Burkholderia pseudomallei

B. Pseudomallei **colonies on agar showing the characteristic cornflower head morphology.**

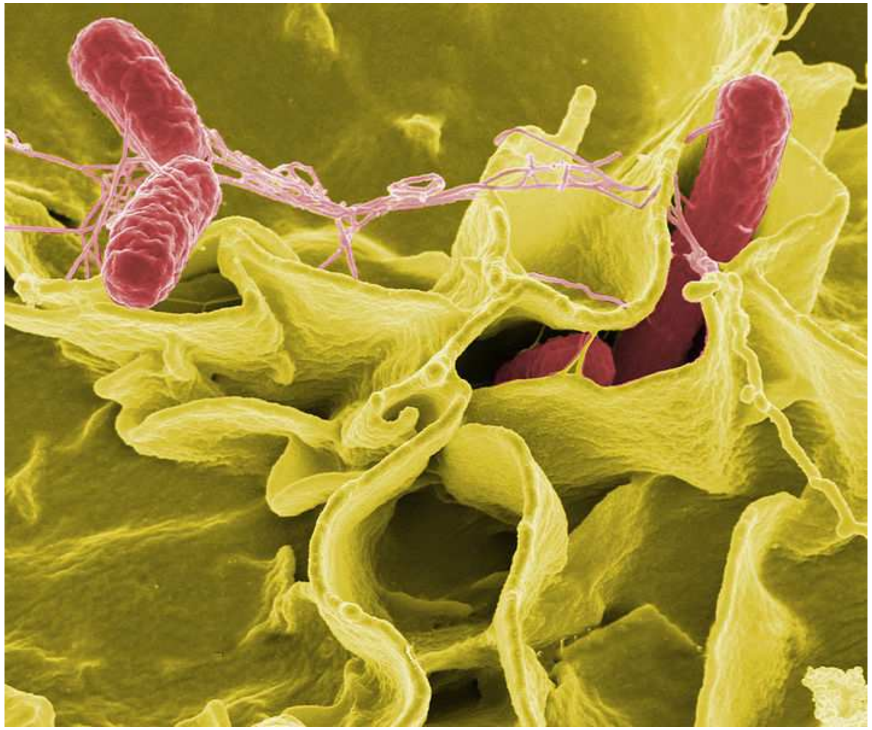
Burkholderia pseudomallei (also known as *Pseudomonas pseudomallei*) is a Gramm-negative, bipolar, aerobic, motile rod-shaped bacterium. It infects humans and animals and causes the disease melioidosis. It is also capable of infecting plants.

B. pseudomallei measures 2-5 μm in length and 0.4-0.8 μm in diameter and are capable of self-propulsion using flagellae. The bacteria can grow in a number of artificial nutrient environments.

Bacteria produce both exo- and endo-toxins. The role of the toxins identified in the process of melioidosis symptom development has not been fully elucidated.

The mortality of melioidosis is 20 to 50% even with treatment.

Salmonella

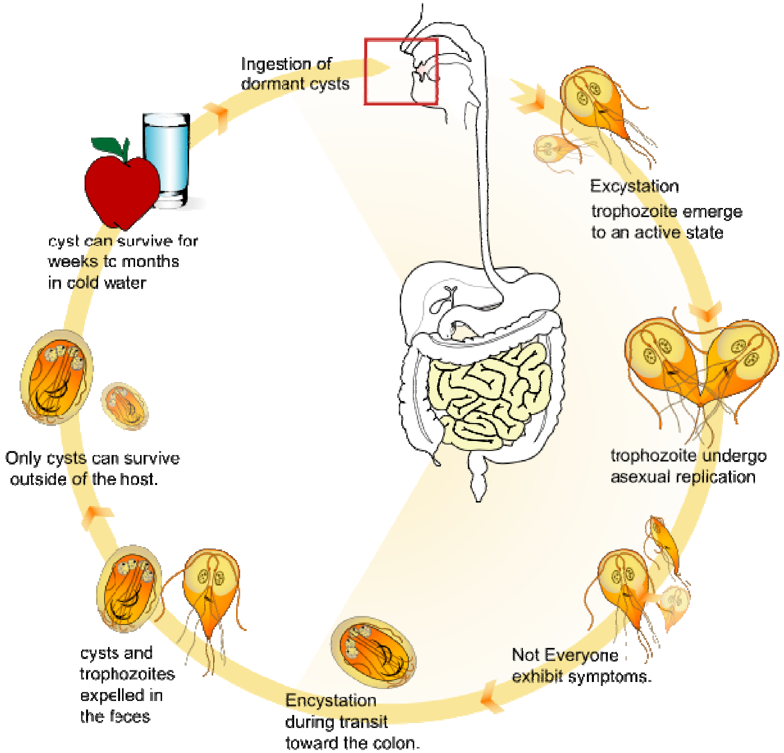


• Infected food, often gaining an unusual colour, odour, or chewiness, that is then introduced into the stream of commerce;
• Poor kitchen hygiene, especially problematic in institutional kitchens and restaurants because this can lead to a significant outbreak;
• Excretions from either sick or infected but apparently clinically healthy people and animals (especially endangered are caregivers and animals);
• Polluted surface water and standing water (such as in shower hoses or unused water dispensers);
• Un-hygienically thawed fowl (the melt water contains many bacteria);
• An association with reptiles (pet tortoises, snakes, and frogs, but primarily aquatic turtles) is well described.

***Salmonella* is a genus of rod-shaped, Gram-negative, non-spore-forming, predominantly motile enterobacteria with diameters around 0.7 to 1.5 µm, lengths from 2 to 5 µm, and flagella which grade in all directions. They obtaining their energy from oxidation and reduction reactions using organic sources, and are facultative anaerobes. *Salmonella* is closely related to the *Escherichia* genus and are found worldwide in cold- and warm-blooded animals (including humans), and in the environment. They cause illnesses like typhoid fever and food-borne illness.**

Giardia lamblia

Giardia infects humans, but is also one of the most common parasites infecting cats, dogs and birds. Mammalian hosts also include cows, beavers, deer, and sheep.



Parasite life cycle

Giardia lamblia is a flagellated protozoan parasite that colonizes and reproduces in the small intestine, causing giardiasis. The giardia parasite attaches to the epilhelium by a ventral adhesive disc, and reproduces via binary fission. Giardiasis does not spread via the bloodstream, nor does it spread to other parts of the gastro-intestinal tract, but remains confined to the lumen of the small intestine. Chief pathways of human infection include ingestion of untreated sewage, a phenomenon particularly common in many developing countries; contamination of natural waters also occurs in watersheds where intensive grazing occurs

WASTEWATER

Wastewater is human changed waters with other physical, chemical and biological properties as natural waters.

Classification of wastewaters by origin:

- **household wastewater**
- **municipal wastewater**
- **precipitation (rain) wastewater**
- **Industrial (production) wastewater**

DOMESTIC SEWAGE

Deer Island Wastewater Treatment Plant serving Boston, Massachusetts.

Domestic sewage is 99.9 percent pure water, while the other 0.1 percent are pollutants. Although found in low concentrations, these pollutants pose risk on a large scale.

In urban areas, domestic sewage is typically treated by centralized sewage treatment plants.

In the EU and US, most of these plants are operated by local government agencies, frequently referred to as publicly owned treatment works.

Municipal treatment plants are designed to control conventional pollutants : BOD and suspended solids.

Well-designed and operated systems (i.e., secondary treatment or better) can remove 90 percent or more of these pollutants. Some plants have additional sub-systems to treat nutrients and pathogens.

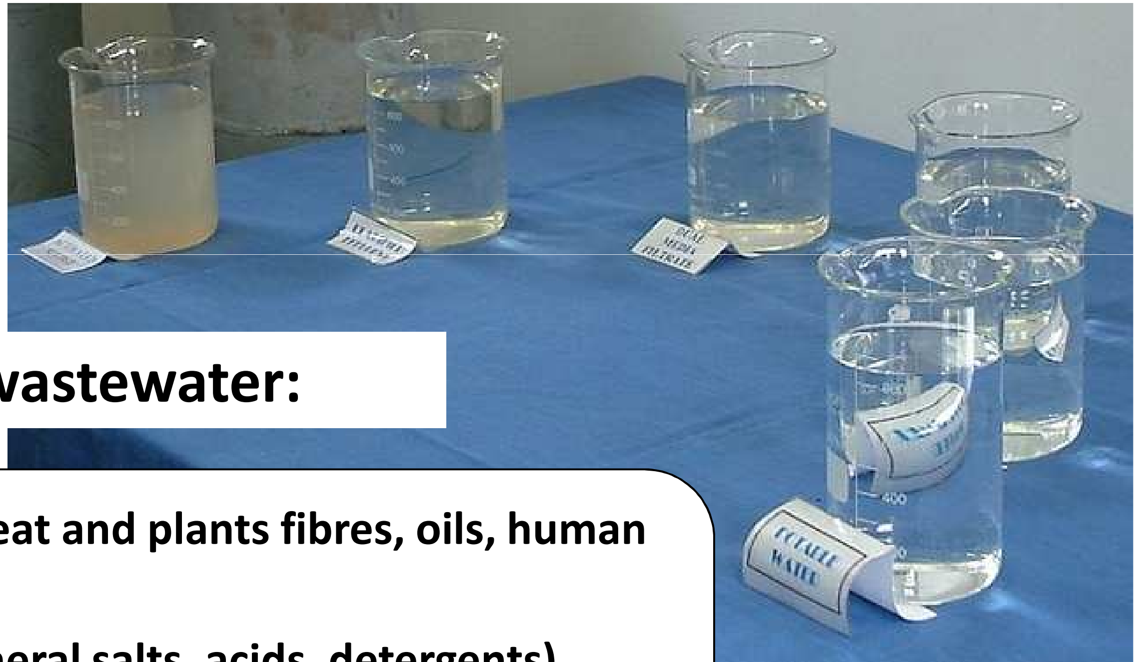
Most municipal plants are not designed to treat toxic pollutants found in industrial wastewater.

HOUSEHOLD WASTEWATER

Household wastewater are produced in apartments, individual family houses or public buildings. Centralized collection of the wastewater is needed by physiological, hygienic and household conditions.

CHARACTERISTICS OF HOUSEHOLDS WASTEWATER

Households wastewater temperature is 8-12°C,
transparency 4-10 cm, grey colour,
medium bog odour, neutral pH reaction



Content of households wastewater:

- **60-80% organic substances (meat and plants fibres, oils, human excrements and urine),**
- **inorganic impurities (sand, mineral salts, acids, detergents),**
- **living organisms: microorganisms, protea, warms,**
- **alkali**

HOUSEHOLDS WASTEWATER QUANTITY

Quantity of wastewater per capita in day:
in small towns are **250 – 300 l,**
in big industrial cities up to **900 l.**

Flow of the wastewater changes by seasons and in the day time. It is dependant of the population in the area.

70-90 % of used water become a wastewater.

URBAN RUNOFF

Effective control of urban runoff involves **reducing the velocity and flow of storm water**, as well as reducing pollutant discharges. Local governments use a variety of storm water management techniques to reduce the effects of urban runoff.

These techniques, called best management practices, may focus on water **quantity control**, while others focus on improving water quality.

Pollution prevention practices include **low impact development techniques** (grass lawn), and **improved chemical handling** (e.g. management of motor fuels and oil, fertilizers and pesticides).

Runoff mitigation (atvieglojuma) systems include infiltration basins, bio-retention systems, **constructed wetlands**, retention basins and similar devices.

Thermal pollution from runoff can be controlled by storm water management facilities that absorb the runoff or direct it into groundwater, such as bio-retention systems and infiltration basins.

Retention (uzkrāšanas) basins tend to be less effective at reducing temperature, as the water may be heated by the sun before being discharged to a receiving stream.

Retention basin for controlling urban runoff

RUNOFF QUANTITY

Runoff quantity varies in wide scale depending of season, geographical location and intensity of the precipitation.

In Latvia average precipitation is approximately 700 mm/y.

There are estimation, that runoff quantity is around 1/4 of the municipal wastewater quantity , but in storm rain water quantity might be considerably higher.

COLLECTION OF THE RAIN WATER

Underground reservoirs, if quantity of water isn't huge

Special land amelioration (uzlabošanas) system, if that is used as separate system.

Household wastewater system in small towns.

Combined municipal and precipitation wastewater system – mainly in big cities.

Special precipitation wastewater system.

INDUSTRIAL WASTEWATER

Some industrial facilities generate ordinary domestic sewage that can be treated by municipal facilities. Industries that generate wastewater with high concentrations of conventional pollutants (e.g. oil and grease), toxic pollutants (e.g. heavy metals, volatile organic compounds) or other nonconventional pollutants such as ammonia, **need specialized treatment systems**.

Some of these facilities can install a **pre-treatment system** to remove the toxic components, and then send the partially-treated wastewater to the municipal system. Industries generating large volumes of wastewater typically operate their own complete on-site treatment systems.

Some industries have been successful at redesigning their manufacturing processes to **reduce or eliminate pollutants**, through a process called pollution prevention.

Heated water generated by power plants or manufacturing plants may be controlled with:

- cooling ponds, man-made bodies of water designed for cooling by evaporation, convection and radiation,
- cooling towers, which transfer waste heat to the atmosphere through evaporation and heat transfer,
- cogeneration, a process where waste heat is recycled for domestic and/or industrial heating purposes.

INDUSTRIAL WASTEWATER

Mine wastewater effluent with neutralized pH from tailing runoff, Peru

Dissolved air flotation system for treating industrial wastewater

Discharge from a Chinese fertilizer factory winds its way toward the Yellow River

INDUSTRIAL WASTEWATER

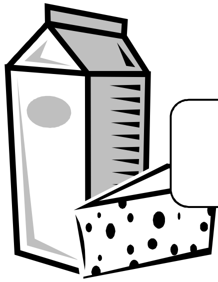
Relatively polluted – used for heat exchangers (cooling needed)

Polluted – contain different chemicals (treatment needed before to feed in municipal sewage system)

Very polluted – if on the site isn't possibility for treatment, necessary to fill in containers and send to especial treatment plant

INDUSTRIAL WASTEWATER QUANTITY

Wastewater amount by processing of the one unit (kg or l) of the product:

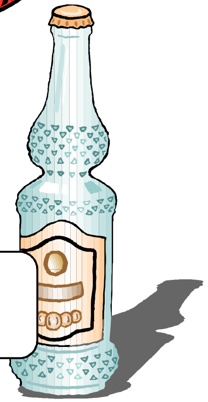


Milk: 0,5-4 l

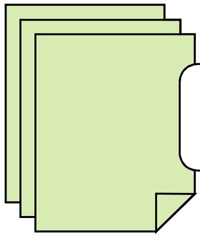
Meat: 1-3 l

Canned fish : 17-45 l

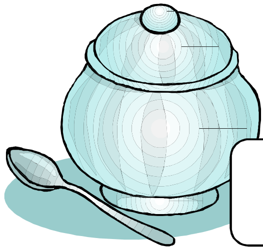
Beer: 2,5-15 l



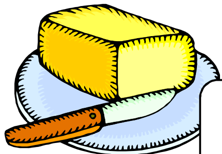
Liquor: 15-20 l



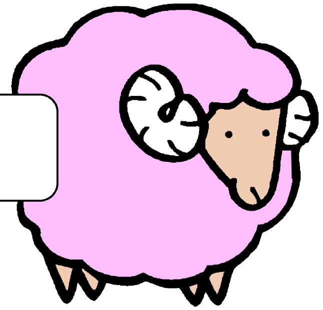
Paper: 10-20 l



Sugar: 100 l



Margarine: 40-60 l



Wool: 100 l

Coal: 20-30 l

Cellulose: 80-150 l

INDUSTRIAL WASTEWATER TREATMENT

Flotation system for industrial wastewater treatment

AGRICULTURAL WASTEWATER

Nonpoint source controls

Sediment (loose soil) washed off fields is the largest source of agricultural pollution. Farmers may utilize erosion controls to reduce runoff flows and retain soil on their fields. Common techniques include contour ploughing, crop mulching, crop rotation, planting perennial crops and installing riparian buffers.

Nutrients (nitrogen and phosphorus) are typically applied to farmland as commercial fertilizer; animal manure; or spraying of municipal or industrial wastewater (effluent) or sludge. Nutrients may also enter runoff from crop residues, irrigation water, wildlife and atmospheric deposition. Farmers can develop and implement nutrient management plans to reduce excess application of nutrients.

Point source wastewater treatment

Farms with large livestock and poultry operations, such as factory farms, are called *concentrated animal feeding operations* or *confined animal feeding operations* in the US and are being subject to increasing government regulation.

Animal slurries are usually treated by containment in lagoons before disposal by spray or trickle application to grassland.

Constructed wetlands are sometimes used to facilitate treatment of animal wastes, as are anaerobic lagoons. Some animal slurries are treated by mixing with straw and composted at high temperature to produce a bacteriologic ally sterile and friable manure for soil improvement.

AGRICULTURAL WASTEWATER

Riparian buffer lining a creek in Iowa.

Confined Animal Feeding Operation in the US.

Silt fence installed on a construction site.

MUNICIPAL WASTEWATER

Municipal wastewater is mixture of the household and industrial wastewaters with or without precipitation water.

Content of the municipal wastewater:

- Different solid participles
- N and P compounds
- Stable organic substances
- Ions of the metals
- Microorganisms
- Other compounds

WASTEWATER PARAMETERS

- Biochemical oxygen demand (BOD) - 250 mg/l
- Chemical oxygen demand (COD) - 500 mg/l
- Ammonia (NH_4-N) - 40 mg/l
- Total nitrogen, including ammonia (NH_4-N) - ($_{Ptot.}$) - 8 mg/l
- Total phosphorus - 8 mg/l
- Participle matter (PM)
- pH 3-8
- Total dissolved substances - 200-1000 mg/l

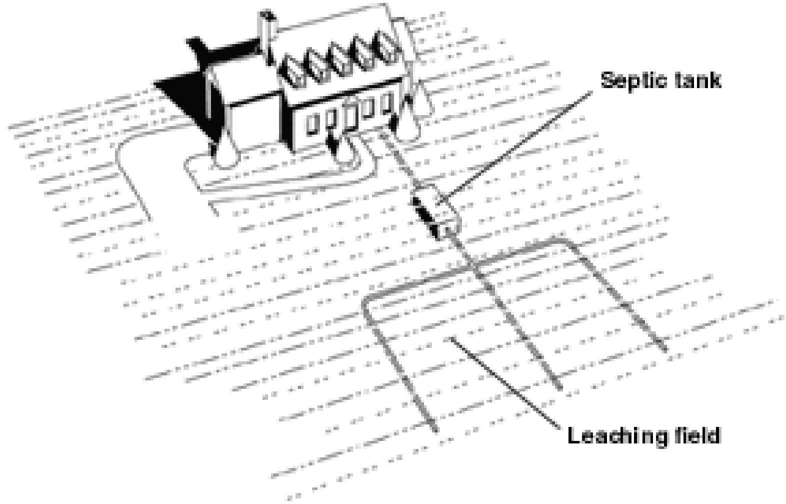
DOMESTIC SEWAGE

Cities with sanitary sewer overflows or combined sewer overflows employ one or more engineering approaches to reduce discharges of untreated sewage, including:

- utilizing a green infrastructure approach to improve stormwater management capacity throughout the system, and reduce the hydraulic overloading of the treatment plant;
- repair and replacement of leaking and malfunctioning equipment;
- increasing overall hydraulic capacity of the sewage collection system (often a very expensive option.

A household or business not served by a municipal treatment plant may have an individual septic tank, which treats the wastewater on site and discharges into the soil. Alternatively, domestic wastewater may be sent to a nearby privately owned treatment system (e.g. in a rural community).

The septic tank partially installed in the ground



Septic drain field

SEPTIC TANK

A septic tank generally consists of a tank (or sometimes more than one tank) of between **4000 and 7500 litres in size** connected to an inlet wastewater pipe at one end and a septic drain field at the other.

Design of the tank usually incorporates **two** separated chambers (each of which is equipped with a manhole cover).

Wastewater enters the **first chamber** of the tank, allowing solids to settle and scum to float. The settled solids are anaerobically digested, reducing the volume of solids.

The liquid component flows through the dividing wall into the **second chamber**, where further settlement takes place, with the excess liquid then draining in a relatively clear condition from the outlet into the leach field, also referred to as a drain field or seepage field, depending upon locality.

The remaining impurities are trapped and eliminated in the **soil**, with the excess water eliminated through percolation into the soil (eventually returning to the groundwater), through evaporation, and by uptake through the root system of plants and eventual transpiration.

A piping network, often laid in a stone-filled trench, distributes the wastewater throughout the field with multiple drainage holes in the network.

The size of the **leach field** is proportional to the volume of wastewater and inversely proportional to the porosity of the drainage field.

The entire septic system can operate by **gravity** alone or, where topographic considerations require, with inclusion of a lift pump.

A well-designed and - maintained concrete, fiberglass, or plastic tank should last about 50 years.

SEPTIC TANK

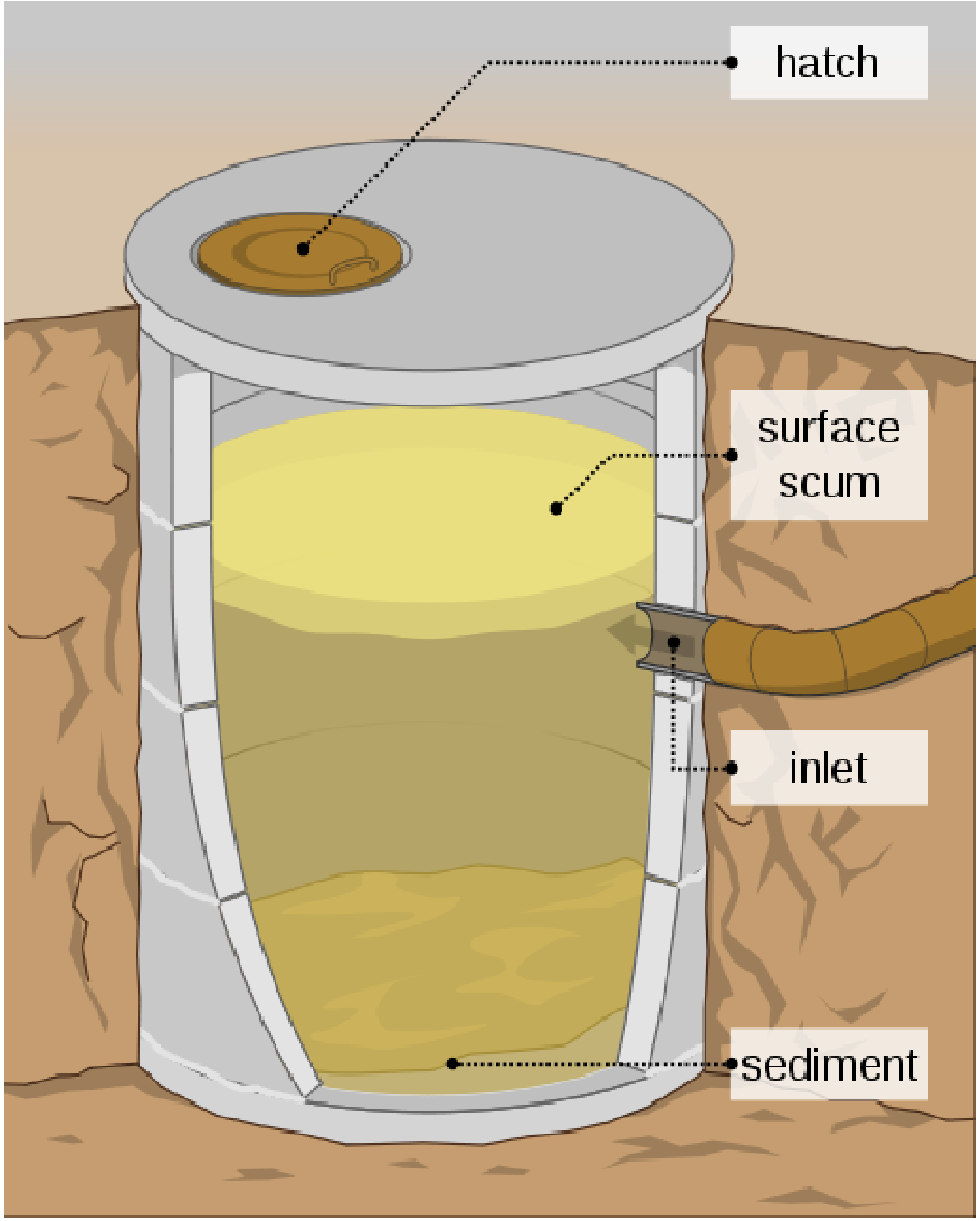
Waste that is not decomposed by the anaerobic digestion eventually has to be removed from the septic tank, or else the septic tank fills up and undecomposed wastewater discharges directly to the drainage field. Not only is this bad for the environment but, if the sludge overflows the septic tank into the leach field, it may clog the leach field piping or decrease the soil porosity itself, requiring expensive repairs.

How often the septic tank has to be emptied depends on the volume of the tank relative to the input of solids, the amount of indigestible solids, and the ambient temperature (as anaerobic digestion occurs more efficiently at higher temperatures). The required frequency varies greatly depending on jurisdiction, usage, and system characteristics.

Some systems require pumping every few years or sooner, while others may be able to go 10–20 years between pumpings. Contrary to what many believe, there is no "rule of thumb" for how often tanks should be emptied. An older system with an undersize tank that is being used by a large family will require much more frequent pumping than a new system used by only a few people. Anaerobic decomposition is rapidly re-started when the tank re-fills.

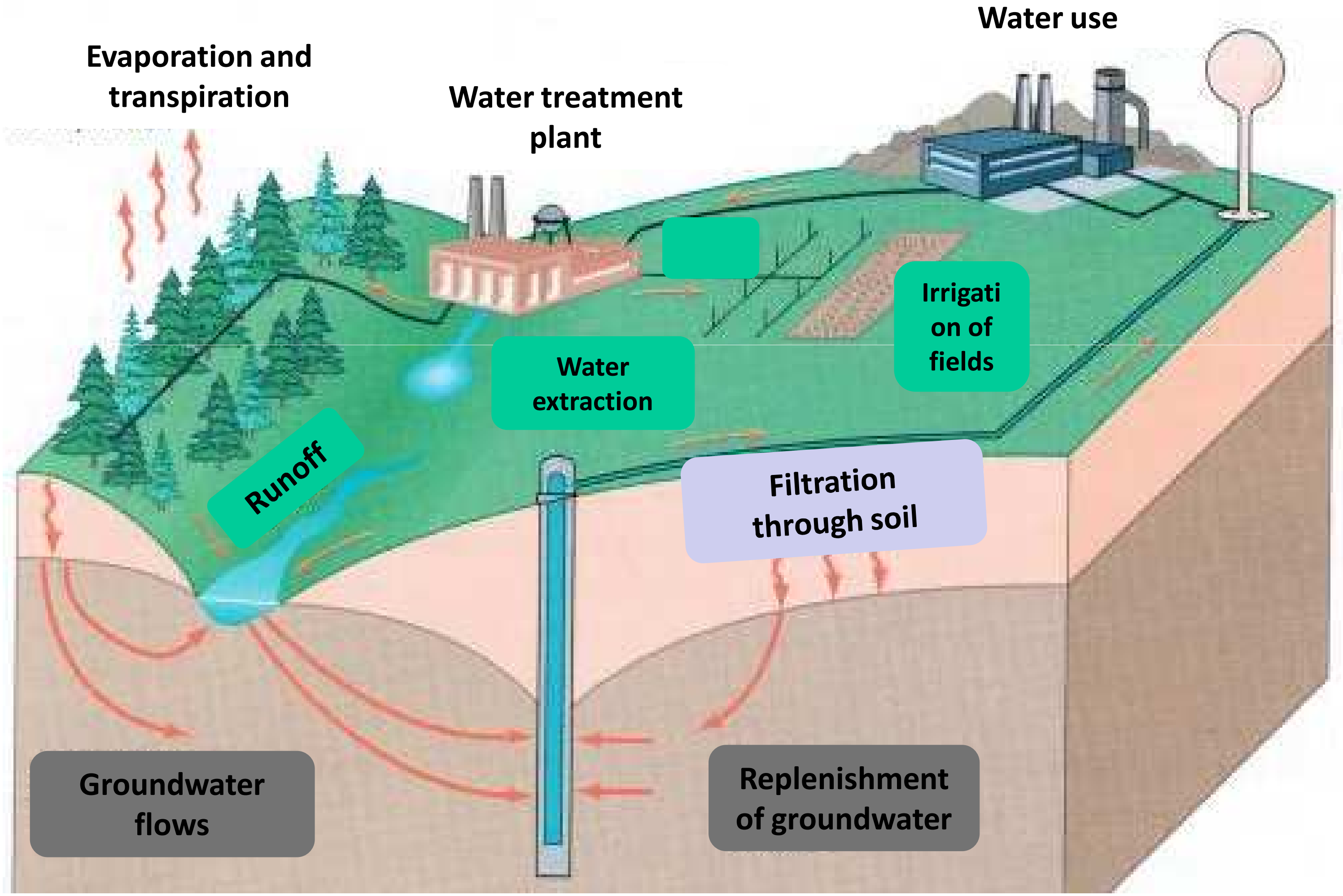
A properly designed and normally operating septic system is odor-free and, besides periodic inspection and pumping of the septic tank, should last for decades with no maintenance.

A well-designed and - maintained concrete, fiberglass, or plastic tank should last about 50 years.



SEPTIC TANK

ANTROPHOGENIC WATER TURNOVER CYCLE



THANK YOU FOR ATTENTION !