Virginia Rentals

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Sanitation

Factors Influencing Daily Porta Potty Rental Costs

Understanding the Basics of Volume Discounts in Porta Potty Rentals

When it comes to renting portable sanitation solutions like porta potties, understanding the concept of volume discounts can significantly impact your overall costs. Volume discounts are essentially a reduction in the rental price offered by the provider when you rent a larger quantity of units. Environmental considerations in Virginia include proper waste disposal and minimal impact on sensitive areas like historic sites **porta-potty rental** Cleanliness. This pricing strategy is designed to incentivize bulk purchases, making it more cost-effective for businesses and organizations that need multiple units for extended periods or large events.

The primary advantage of volume discounts is the potential for substantial savings. By renting a higher number of porta potties, you can often negotiate a lower per-unit price. This is particularly beneficial for events such as festivals, construction sites, or large-scale gatherings where numerous portable toilets are required. For instance, if the standard rental rate for a single porta potty is $20 per day, a volume discount might reduce this rate to $15 per day for orders of 20 or more units. This reduction can lead to significant savings when multiplied over the duration of the rental period and the number of units needed.

Another benefit of volume discounts is the convenience and efficiency they offer. Renting a large number of porta potties at a discounted rate simplifies logistics and reduces the administrative burden. Instead of managing multiple smaller orders, you can handle a single, larger order, which can be easier to coordinate and track. This streamlined approach can save time and resources, allowing you to focus on other critical aspects of your event or project.

Negotiating volume discounts also requires a strategic approach. To secure the best possible rates, its essential to communicate your needs clearly to the rental provider. Be prepared to discuss the duration of the rental, the exact number of units required, and any specific requirements or preferences. Providers are often willing to work with clients to find a mutually beneficial arrangement, so dont hesitate to express your interest in a volume discount and inquire about available options.

In summary, understanding and leveraging volume discounts in porta potty rentals can lead to considerable cost savings and operational efficiencies. By renting a larger quantity of units, you can take advantage of reduced per-unit prices, making your portable sanitation solution more affordable and manageable. Effective negotiation and clear communication with your rental provider are key to maximizing the benefits of volume discounts.

Okay, so youre looking to wrangle some sweet volume discounts on portable sanitation, huh? Makes sense. Nobody wants to pay full price, especially when youre buying in bulk. Think of it like this: youre not just buying toilets; youre building a relationship. A relationship where youre a valued customer who brings them a predictable stream of revenue.

First, do your homework. Knowledge is power, especially when negotiating. Know their pricing structure, understand the market rate, and figure out what your absolute minimum viable price is. Dont be afraid to call around and get quotes from different suppliers. This gives you leverage and shows them youre serious.

Next, be upfront about your needs. Tell them exactly how many units you need, how frequently you need them serviced, and for how long. The more specific you are, the better they can understand the potential value of your business. Frame it in a way that highlights the benefits for them. "Were projecting a steady need for X units per month for the next year, which translates into Y in revenue for you." Thats music to their ears.

Dont be afraid to negotiate beyond just the per-unit price. Can you get free delivery with a certain volume? What about a discount on servicing? Maybe they can throw in some extra hand sanitizer or toilet paper? Think outside the box and look for ways to add value to the deal.

Finally, be prepared to walk away. This is crucial. If theyre not willing to meet your needs, dont be afraid to explore other options. Sometimes, the threat of losing your business is enough to get them to reconsider. And remember, a good negotiation is one where both parties feel like theyve won something. You want them to be happy with the deal too, so theyre motivated to provide you with excellent service. Happy negotiating!

restroom rentals virginia

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Comparing Daily vs. Weekly Rental: Which is Best for You?

Okay, lets talk about getting a sweet deal on portable toilets. Specifically, how some folks have really knocked it out of the park when negotiating volume discounts. Were talking about "Case Studies: Successful Volume Discount Negotiations for Portable Sanitation." Now, this isnt rocket science, but theres definitely an art to it.

Think about it. Youre a contractor, maybe running a massive construction site, or youre organizing a huge outdoor festival. You need a *lot* of portable toilets. And youre staring at a bill thats making your eyes water. This is where the magic happens.

The first case study that comes to mind is a large construction company that was building a new apartment complex. They knew they needed dozens of units for months on end. Instead of just accepting the initial quote, they did their homework. They got quotes from multiple suppliers, and then, armed with that information, they went back to their preferred supplier. "Look," they said, in essence, "We like you guys, but were getting a better price over here. Can you match it, or at least come closer?" The key was having those competing bids. It gave them leverage. And guess what? The supplier budged. They werent willing to lose that much business.

Another example is a music festival organizer. They took a different approach. Instead of just focusing on price per unit, they negotiated on the *total cost of ownership*. They emphasized the long-term benefits of a partnership. They promised repeat business for future festivals, and they highlighted the positive word-of-mouth they could generate if the service was excellent. They essentially said, "Were not just buying toilets; were investing in a relationship." This shifted the focus from a simple transaction to a mutually beneficial agreement, and they secured a significant discount.

The common thread in these success stories? Preparation and a little bit of savvy. You need to know your needs, understand the market, and be willing to walk away (or at least threaten to). Dont be afraid to negotiate beyond just the unit price. Consider service frequency, delivery schedules, and even the cleanliness standards. Get everything in writing, too – no handshake deals.

Ultimately, successful volume discount negotiation in portable sanitation comes down to knowing your worth as a customer and making a compelling case for why the supplier should give you the best possible deal. Its a dance, but when done right, everyone wins.

Hidden Fees and Extra Charges to Consider

Negotiating volume discounts in portable sanitation can be a game-changer for businesses that frequently require these services. By leveraging the power of bulk purchasing, companies can significantly reduce their operational costs. Here are some tips to maximize savings through volume discounts in this sector.

First, understand the market. Research various suppliers to identify those who offer volume discounts. Not all companies provide this benefit, so its crucial to know who does and who doesnt. This knowledge will give you leverage when negotiating.

Next, be prepared with data. When approaching a supplier, present them with your usage history and projected needs. This transparency helps suppliers see the potential for a long-term partnership, making them more inclined to offer discounts. For instance, if you consistently use 50 portable toilets monthly, showing this trend can help justify a bulk purchase agreement.

Timing is key. Negotiate during off-peak seasons when suppliers are more willing to offer discounts to fill their inventory. This strategy can lead to better terms and savings.

Dont hesitate to ask for more than you need. Suppliers might be willing to offer a better deal if you commit to a larger quantity. This approach can sometimes yield unexpected savings.

Consider bundling services. If you require multiple services, such as portable toilets and waste management, ask for a combined discount. Suppliers often offer better rates when services are purchased together.

Finally, maintain a good relationship with your supplier. Regular communication and prompt payments can lead to better terms and loyalty discounts. Suppliers appreciate clients who are easy to work with and are likely to return for future needs.

By following these tips, businesses can effectively negotiate volume discounts in portable sanitation, leading to substantial savings and improved financial health.

About Sewage treatment

This article is about the treatment of municipal wastewater. For the treatment of any type of wastewater, see Wastewater treatment.

Aerial photo of Kuryanovo

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Constructed wetlands fo

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Waste stabilization pond

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UASB for domestic wastev

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Sewage treatment plants (STPs) come in many different sizes and process configurations.

Clockwise from top left: Aerial photo of Kuryanovo activated sludge STP in Moscow, Russia; Constructed wetlands STP near Gdansk, Poland; Waste stabilization ponds STP in the South of France; Upflow anaerobic sludge blanket STP in Bucaramanga, Colombia.

Sewage treatment	
Synonym	Wastewater treatment plant (WWTP), water reclamation plant
Position in sanitation chain	Treatment
Application level	City, neighborhood[1]
Management level	Public
Inputs	Sewage, could also be just blackwater (waste), greywater[1]
Outputs	Effluent, sewage sludge, possibly biogas (for some types)[1]
Types	List of wastewater treatment technologies
Environmental concerns	Water pollution, Environmental health, Public health, sewage sludge disposal issues

Sewage treatment is a type of wastewater treatment which aims to remove contaminants from sewage to produce an effluent that is suitable to discharge to the surrounding environment or an intended reuse application, thereby preventing water pollution from raw sewage discharges.[2] Sewage contains wastewater from households and businesses and possibly pre-treated industrial wastewater. There are a large number of sewage treatment processes to choose from. These can range from decentralized systems (including on-site treatment systems) to large centralized systems involving a network of pipes and pump stations (called sewerage) which convey the sewage to a treatment plant. For cities that have a combined sewer, the sewers will also carry urban runoff (stormwater) to the sewage treatment plant. Sewage treatment often involves two main stages, called primary and secondary treatment, while advanced treatment also incorporates a tertiary treatment stage with polishing processes and nutrient removal. Secondary treatment can reduce organic matter (measured as biological oxygen demand) from sewage,â€Š using aerobic or anaerobic biological processes. A so-called quaternary treatment step (sometimes referred to as advanced treatment) can also be added for the removal of organic micropollutants, such as pharmaceuticals. This has been implemented in full-scale for example in Sweden.[3]

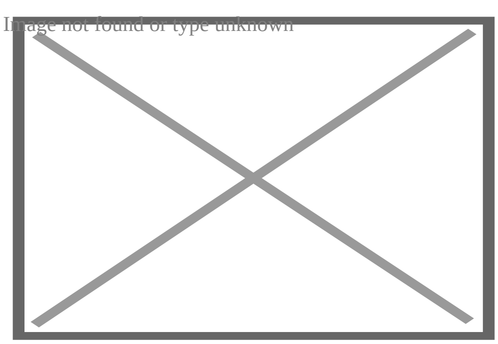
A large number of sewage treatment technologies have been developed, mostly using biological treatment processes. Design engineers and decision makers need to take into account technical and economical criteria of each alternative when choosing a suitable technology.[4]:â€Š215â€Š Often, the main criteria for selection are desired effluent quality, expected construction and operating costs, availability of land, energy requirements and sustainability aspects. In developing countries and in rural areas with low population densities, sewage is often treated by various on-site sanitation systems and not conveyed in sewers. These systems include septic tanks connected to drain fields, on-site sewage systems (OSS), vermifilter systems and many more. On the other hand, advanced and relatively expensive sewage treatment plants may include tertiary treatment with disinfection and possibly even a fourth treatment stage to remove micropollutants.[3]

At the global level, an estimated 52% of sewage is treated.[5] However, sewage treatment rates are highly unequal for different countries around the world. For example, while high-income countries treat approximately 74% of their sewage, developing countries treat an average of just 4.2%.[5]

The treatment of sewage is part of the field of sanitation. Sanitation also includes the management of human waste and solid waste as well as stormwater (drainage) management.[6] The term *sewage treatment plant* is often used interchangeably with the term *wastewater treatment plant*.[4][*page needed*][7]

Terminology

[edit]



Activated sludge sewage treatment plant in Massachusetts, US

The term *sewage treatment plant* (STP) (or *sewage treatment works*) is nowadays often replaced with the term *wastewater treatment plant* (WWTP).[7][8] Strictly speaking, the latter is a broader term that can also refer to industrial wastewater treatment.

The terms *water recycling center* or *water reclamation plants* are also in use as synonyms.

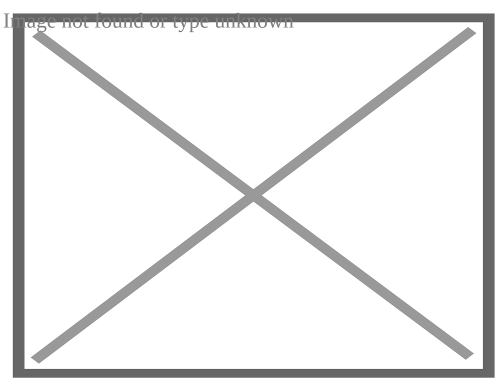
Purposes and overview

[edit]

The overall aim of treating sewage is to produce an effluent that can be discharged to the environment while causing as little water pollution as possible, or to produce an effluent that can be reused in a useful manner.[9] This is achieved by removing contaminants from the sewage. It is a form of waste management.

With regards to biological treatment of sewage, the treatment objectives can include various degrees of the following: to transform or remove organic matter, nutrients (nitrogen and phosphorus), pathogenic organisms, and specific trace organic constituents (micropollutants).[7]:â€Š548â€Š

Some types of sewage treatment produce sewage sludge which can be treated before safe disposal or reuse. Under certain circumstances, the treated sewage sludge might be termed *biosolids* and can be used as a fertilizer.



The process that raw sewage goes through before being released back into surface water

Sewage characteristics

[edit]
This section is an excerpt from Sewage § Concentrations and loads. [edit]

Typical values for physical–chemical characteristics of raw sewage in developing countries have been published as follows: 180 g/person/d for total solids (or 1100 mg/L when expressed as a concentration), 50 g/person/d for BOD (300 mg/L), 100 g/person/d for COD (600 mg/L), 8 g/person/d for total nitrogen (45 mg/L), 4.5 g/person/d for ammonia-N (25 mg/L) and 1.0 g/person/d for total phosphorus (7 mg/L).[10]:â€Š57â€Š The typical ranges for these values are: 120–220 g/person/d for total solids (or 700–1350 mg/L when expressed as a concentration), 40–60 g/person/d for BOD (250–400 mg/L), 80–120 g/person/d for COD (450–800 mg/L), 6–10 g/person/d for total nitrogen (35–60 mg/L), 3.5–6 g/person/d for ammonia-N (20–35 mg/L) and 0.7–2.5 g/person/d for total phosphorus (4–15 mg/L). [10]:â€Š57â€Š

For high income countries, the "per person organic matter load" has been found to be approximately 60 gram of BOD per person per day. [11] This is called the population equivalent (PE) and is also used as a comparison parameter to express the strength of industrial wastewater compared to sewage.

Collection

[edit]

This section is an excerpt from Sewerage. [edit]

Sewerage (or sewage system) is the infrastructure that conveys sewage or surface runoff (stormwater, meltwater, rainwater) using sewers. It encompasses components such as receiving drains, manholes, pumping stations, storm overflows, and screening chambers of the combined sewer or sanitary sewer. Sewerage ends at the entry to a sewage treatment plant or at the point of discharge into the environment. It is the system of pipes, chambers, manholes or inspection chamber, etc. that conveys the sewage or storm water.
In many cities, sewage (municipal wastewater or municipal sewage) is carried together with stormwater, in a combined sewer system, to a sewage treatment plant. In some urban areas, sewage is carried separately in sanitary sewers and runoff from streets is carried in storm drains. Access to these systems, for maintenance purposes, is typically through a manhole. During high precipitation periods a sewer system may experience a combined sewer overflow event or a sanitary sewer overflow event, which forces untreated sewage to flow directly to receiving waters. This can pose a serious threat to public health and the surrounding environment.

Types of treatment processes

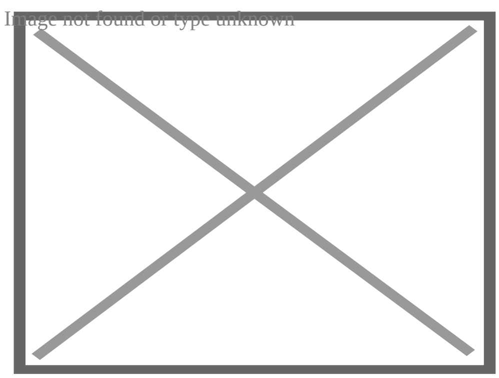
[edit]

Sewage can be treated close to where the sewage is created, which may be called a *decentralized system* or even an *on-site system* (on-site sewage facility, septic tanks, etc.). Alternatively, sewage can be collected and transported by a network of pipes and pump stations to a municipal treatment plant. This is called a *centralized system* (see also sewerage and pipes and infrastructure).

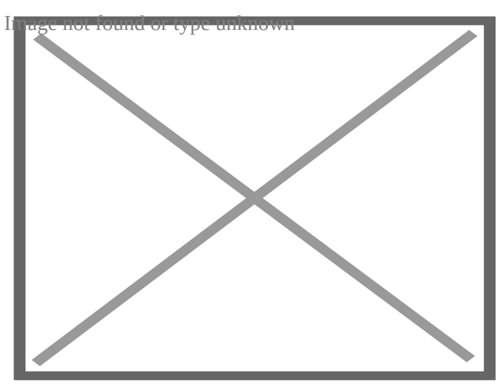
A large number of sewage treatment technologies have been developed, mostly using biological treatment processes (see list of wastewater treatment technologies). Very broadly, they can be grouped into high tech (high cost) versus low tech (low cost) options, although some technologies might fall into either category. Other grouping classifications are *intensive* or *mechanized* systems (more compact, and frequently employing high tech options) versus *extensive* or *natural* or *nature-based* systems (usually using natural treatment processes and occupying larger areas) systems. This classification may be sometimes oversimplified, because a treatment plant may involve a combination of processes, and the interpretation of the concepts of high tech and low tech, intensive and extensive, mechanized and natural processes may vary from place to place.

Low tech, extensive or nature-based processes

[edit]

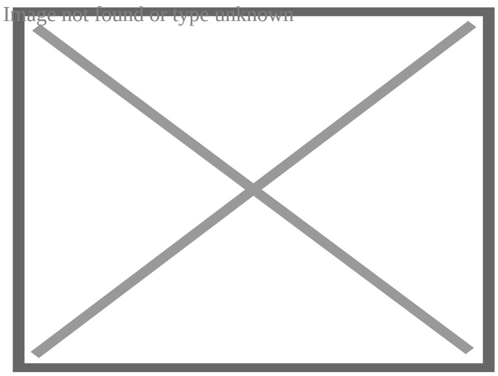


Constructed wetland (vertical flow) at Center for Research and Training in Sanitation, Belo Horizonte, Brazil



Trickling filter sewage treatment plant at Onça Treatment Plant, Belo Horizonte, Brazil

Examples for more low-tech, often less expensive sewage treatment systems are shown below. They often use little or no energy. Some of these systems do not provide a high level of treatment, or only treat part of the sewage (for example only the toilet wastewater), or they only provide pre-treatment, like septic tanks. On the other hand, some systems are capable of providing a good performance, satisfactory for several applications. Many of these systems are based on natural treatment processes, requiring large areas, while others are more compact. In most cases, they are used in rural areas or in small to medium-sized communities.



Rural Kansas lagoon on private property

For example, waste stabilization ponds are a low cost treatment option with practically no energy requirements but they require a lot of land.[4]:â€Š236â€Š Due to their technical simplicity, most of the savings (compared with high tech systems) are in terms of operation and maintenance costs.[4]:â€Š220–243â€Š

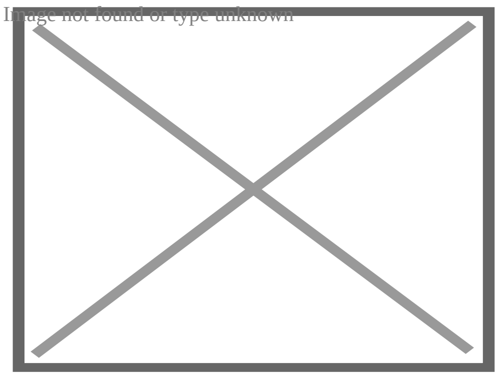
- Anaerobic digester types and anaerobic digestion, for example:
  - Upflow anaerobic sludge blanket reactor
  - Septic tank
  - Imhoff tank
- Constructed wetland (see also biofilters)
- Decentralized wastewater system
- Nature-based solutions
- On-site sewage facility
- Sand filter
- Vermifilter
- Waste stabilization pond with sub-types:[4]:â€Š189â€Š
  - e.g. Facultative ponds, high rate ponds, maturation ponds

Examples for systems that can provide full or partial treatment for toilet wastewater only:

- Composting toilet (see also dry toilets in general)
- Urine-diverting dry toilet
- Vermifilter toilet

High tech, intensive or mechanized processes

[edit]



Aeration tank of activated sludge sewage treatment plant (fine-bubble diffusers) near Adelaide, Australia

Examples for more high-tech, intensive or mechanized, often relatively expensive sewage treatment systems are listed below. Some of them are energy intensive as well. Many of them provide a very high level of treatment. For example, broadly speaking, the activated sludge process achieves a high effluent quality but is relatively expensive and energy intensive.[4]:â€Š239â€Š

- Activated sludge systems
- Aerobic treatment system
- Enhanced biological phosphorus removal
- Expanded granular sludge bed digestion
- Filtration
- Membrane bioreactor
- Moving bed biofilm reactor
- Rotating biological contactor
- Trickling filter
- Ultraviolet disinfection

Disposal or treatment options

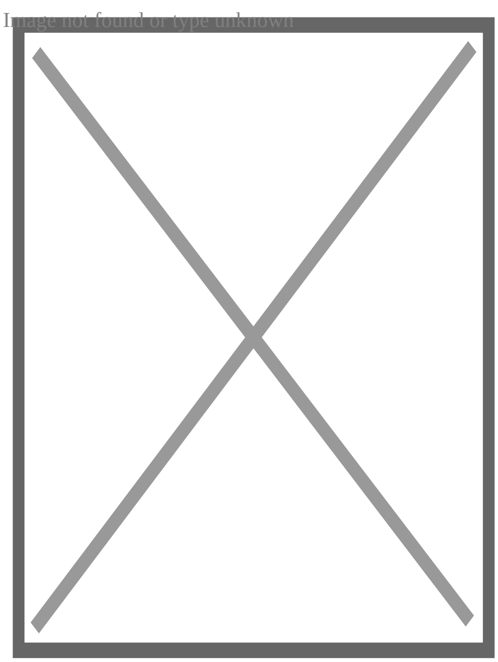
[edit]

There are other process options which may be classified as disposal options, although they can also be understood as basic treatment options. These include: Application of sludge, irrigation, soak pit, leach field, fish pond, floating plant pond, water disposal/groundwater recharge, surface disposal and storage.[12]:â€Š138â€Š

The application of sewage to land is both: a type of treatment and a type of final disposal.[4]:â€Š189â€Š It leads to groundwater recharge and/or to evapotranspiration. Land application include slow-rate systems, rapid infiltration, subsurface infiltration, overland flow. It is done by flooding, furrows, sprinkler and dripping. It is a treatment/disposal system that requires a large amount of land per person.

Design aspects

[edit]



Upflow anaerobic sludge blanket (UASB) reactor in Brazil (picture from a small-sized treatment plant), Center for Research and Training in Sanitation, Belo Horizonte, Brazil

Population equivalent

[edit]

The *per person organic matter load* is a parameter used in the design of sewage treatment plants. This concept is known as population equivalent (PE). The base value used for PE can vary from one country to another. Commonly used definitions used worldwide are: 1 PE equates to 60 gram of BOD per person per day, and it also equals

200 liters of sewage per day.[13] This concept is also used as a comparison parameter to express the strength of industrial wastewater compared to sewage.

Process selection

[edit]

When choosing a suitable sewage treatment process, decision makers need to take into account technical and economical criteria.[4]:â€Š215â€Š Therefore, each analysis is site-specific. A life cycle assessment (LCA) can be used, and criteria or weightings are attributed to the various aspects. This makes the final decision subjective to some extent.[4]:â€Š216â€Š A range of publications exist to help with technology selection.[4]:â€Š221â€Š[12][14][15]

In industrialized countries, the most important parameters in process selection are typically efficiency, reliability, and space requirements. In developing countries, they might be different and the focus might be more on construction and operating costs as well as process simplicity.[4]:â€Š218â€Š

Choosing the most suitable treatment process is complicated and requires expert inputs, often in the form of feasibility studies. This is because the main important factors to be considered when evaluating and selecting sewage treatment processes are numerous. They include: process applicability, applicable flow, acceptable flow variation, influent characteristics, inhibiting or refractory compounds, climatic aspects, process kinetics and reactor hydraulics, performance, treatment residuals, sludge processing, environmental constraints, requirements for chemical products, energy and other resources; requirements for personnel, operating and maintenance; ancillary processes, reliability, complexity, compatibility, area availability.[4]:â€Š219â€Š

With regards to environmental impacts of sewage treatment plants the following aspects are included in the selection process: Odors, vector attraction, sludge transportation, sanitary risks, air contamination, soil and subsoil contamination, surface water pollution or groundwater contamination, devaluation of nearby areas, inconvenience to the nearby population.[4]:â€Š220â€Š

Odor control

[edit]

Odors emitted by sewage treatment are typically an indication of an anaerobic or *septic* condition.[16] Early stages of processing will tend to produce foul-smelling gases, with hydrogen sulfide being most common in generating complaints. Large process plants in urban areas will often treat the odors with carbon reactors, a contact media with bio-slimes, small doses of chlorine, or circulating fluids to biologically capture and metabolize the noxious gases.[17] Other methods of odor control exist, including addition of iron salts, hydrogen peroxide, calcium nitrate, etc. to manage hydrogen sulfide levels.[18]

Energy requirements

[edit]

The energy requirements vary with type of treatment process as well as sewage strength. For example, constructed wetlands and stabilization ponds have low energy requirements.[19] In comparison, the activated sludge process has a high energy consumption because it includes an aeration step. Some sewage treatment plants produce biogas from their sewage sludge treatment process by using a process called anaerobic digestion. This process can produce enough energy to meet most of the energy needs of the sewage treatment plant itself.[7]:â€Š1505â€Š

For activated sludge treatment plants in the United States, around 30 percent of the annual operating costs is usually required for energy.[7]:â€Š1703â€Š Most of this electricity is used for aeration, pumping systems and equipment for the dewatering and drying of sewage sludge. Advanced sewage treatment plants, e.g. for nutrient removal, require more energy than plants that only achieve primary or secondary treatment.[7]:â€Š1704â€Š

Small rural plants using trickling filters may operate with no net energy requirements, the whole process being driven by gravitational flow, including tipping bucket flow distribution and the desludging of settlement tanks to drying beds. This is usually only practical in hilly terrain and in areas where the treatment plant is relatively remote from housing because of the difficulty in managing odors.[20][21]

Co-treatment of industrial effluent

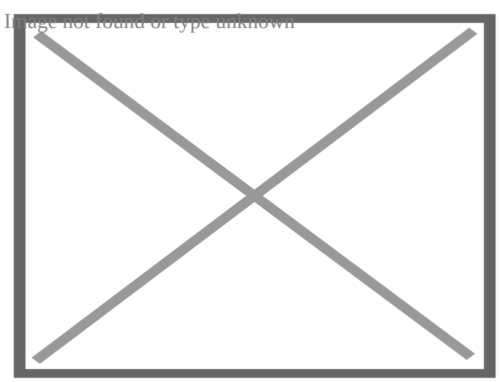
[edit]

In highly regulated developed countries, industrial wastewater usually receives at least pretreatment if not full treatment at the factories themselves to reduce the pollutant load, before discharge to the sewer. The pretreatment has the following two main aims: Firstly, to prevent toxic or inhibitory compounds entering the biological stage of the sewage treatment plant and reduce its efficiency. And secondly to avoid toxic compounds from accumulating in the produced sewage sludge which would reduce its beneficial reuse options. Some industrial wastewater may contain pollutants which cannot be removed by sewage treatment plants. Also, variable flow of industrial waste associated with production cycles may upset the population dynamics of biological treatment units.[*citation needed*]

Design aspects of secondary treatment processes

[edit]

Main article: Secondary treatment § Design considerations



A poorly maintained anaerobic treatment pond in Kariba, Zimbabwe (sludge needs to be removed)

Non-sewered areas

[edit]

Urban residents in many parts of the world rely on on-site sanitation systems without sewers, such as septic tanks and pit latrines, and fecal sludge management in these cities is an enormous challenge.[22]

For sewage treatment the use of septic tanks and other on-site sewage facilities (OSSF) is widespread in some rural areas, for example serving up to 20 percent of the homes in the U.S.[23]

Available process steps

[edit]

Sewage treatment often involves two main stages, called primary and secondary treatment, while advanced treatment also incorporates a tertiary treatment stage with polishing processes.[13] Different types of sewage treatment may utilize some or all of the process steps listed below.

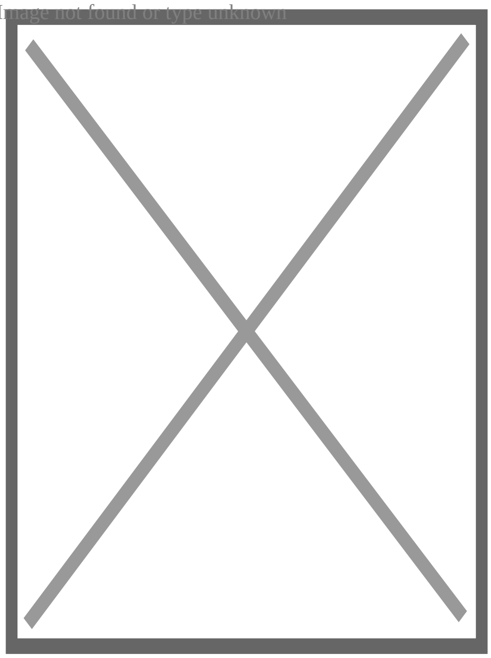
Preliminary treatment

[edit]

Preliminary treatment (sometimes called pretreatment) removes coarse materials that can be easily collected from the raw sewage before they damage or clog the pumps and sewage lines of primary treatment clarifiers.

Screening

[edit]



Preliminary treatment arrangement at small and medium-sized sewage treatment plants: Manually-cleaned screens and grit chamber (Jales Treatment Plant, São Paulo, Brazil)

The influent in sewage water passes through a bar screen to remove all large objects like cans, rags, sticks, plastic packets, etc. carried in the sewage stream. [24] This is most commonly done with an automated mechanically raked bar screen in modern plants serving large populations, while in smaller or less modern plants, a manually cleaned screen may be used. The raking action of a mechanical bar screen is typically paced according to the accumulation on the bar screens and/or flow rate. The solids are collected and later disposed in a landfill, or incinerated. Bar screens or mesh screens of varying sizes may be used to optimize solids removal. If gross solids are not removed, they become entrained in pipes and moving parts of the treatment plant, and can cause substantial damage and inefficiency in the process. [25]:â€Š9â€Š

Grit removal

[edit]

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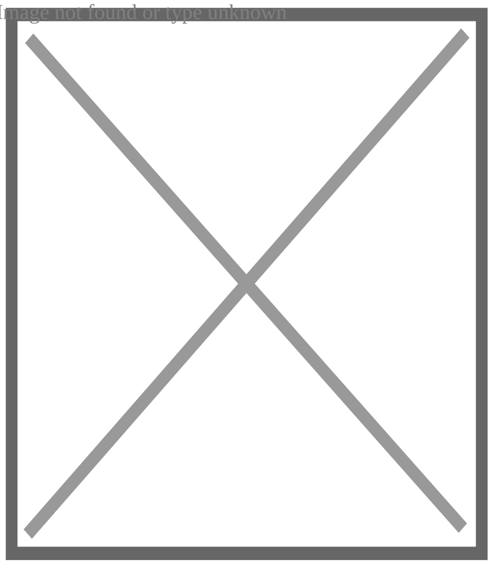


Preliminary treatment: Horizontal flow grit chambers at a sewage treatment plant in Juiz de Fora, Minas Gerais, Brazil

Grit consists of sand, gravel, rocks, and other heavy materials. Preliminary treatment may include a sand or grit removal channel or chamber, where the velocity of the incoming sewage is reduced to allow the settlement of grit. Grit removal is necessary to (1) reduce formation of deposits in primary sedimentation tanks, aeration tanks, anaerobic digesters, pipes, channels, etc. (2) reduce the frequency of tank cleaning caused by excessive accumulation of grit; and (3) protect moving mechanical equipment from abrasion and accompanying abnormal wear. The removal of grit is essential for equipment with closely machined metal surfaces such as comminutors, fine screens, centrifuges, heat exchangers, and high pressure diaphragm pumps.

Grit chambers come in three types: horizontal grit chambers, aerated grit chambers, and vortex grit chambers. Vortex grit chambers include mechanically induced vortex, hydraulically induced vortex, and multi-tray vortex separators. Given that traditionally, grit removal systems have been designed to remove clean inorganic particles that are greater than 0.210 millimetres (0.0083 in), most of the finer grit passes through the grit removal flows under normal conditions. During periods of high flow deposited grit is resuspended and the quantity of grit reaching the treatment plant increases substantially.[7]

Flow equalization

[edit]

Equalization basins can be used to achieve flow equalization. This is especially useful for combined sewer systems which produce peak dry-weather flows or peak wetweather flows that are much higher than the average flows.[7]:â€Š334â€Š Such basins can improve the performance of the biological treatment processes and the secondary clarifiers.[7]:â€Š334â€Š

Disadvantages include the basins' capital cost and space requirements. Basins can also provide a place to temporarily hold, dilute and distribute batch discharges of toxic or high-strength wastewater which might otherwise inhibit biological secondary treatment (such was wastewater from portable toilets or fecal sludge that is brought to the sewage treatment plant in vacuum trucks). Flow equalization basins require variable discharge control, typically include provisions for bypass and cleaning, and may also include aerators and odor control.[26]

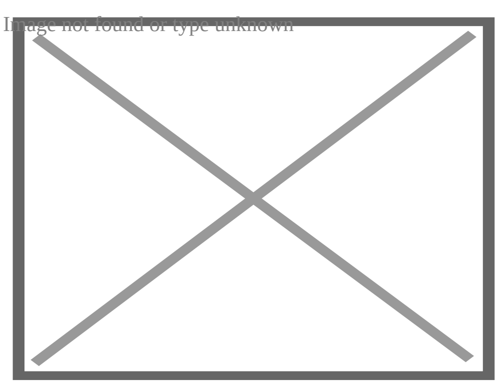
Fat and grease removal

[edit]

In some larger plants, fat and grease are removed by passing the sewage through a small tank where skimmers collect the fat floating on the surface. Air blowers in the base of the tank may also be used to help recover the fat as a froth. Many plants, however, use primary clarifiers with mechanical surface skimmers for fat and grease removal.

Primary treatment

[edit]



Rectangular primary settling tanks at a sewage treatment plant in Oregon, US

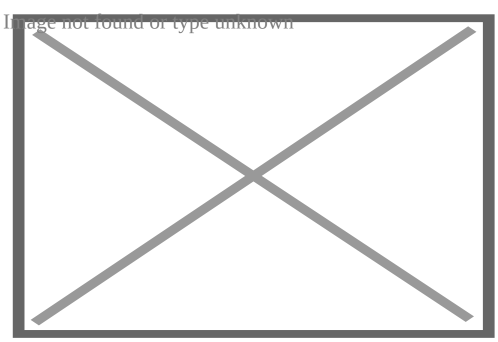
Primary treatment is the "removal of a portion of the suspended solids and organic matter from the sewage".[7]:â€Š11â€ŠIt consists of allowing sewage to pass slowly through a basin where heavy solids can settle to the bottom while oil, grease and lighter solids float to the surface and are skimmed off. These basins are called *primary sedimentation tanks* or *primary clarifiers* and typically have a hydraulic retention time (HRT) of 1.5 to 2.5 hours.[7]:â€Š398â€Š The settled and floating materials are removed and the remaining liquid may be discharged or subjected to secondary treatment. Primary settling tanks are usually equipped with mechanically driven scrapers that continually drive the collected sludge towards a hopper in the base of the tank where it is pumped to sludge treatment facilities.[25]:â€Š9–11â€Š

Sewage treatment plants that are connected to a combined sewer system sometimes have a bypass arrangement after the primary treatment unit. This means that during very heavy rainfall events, the secondary and tertiary treatment systems can be bypassed to protect them from hydraulic overloading, and the mixture of sewage and storm-water receives primary treatment only.[27]

Primary sedimentation tanks remove about 50–70% of the suspended solids, and 25–40% of the biological oxygen demand (BOD).[7]:â€Š396â€Š

Secondary treatment

[edit]
Main article: Secondary treatment



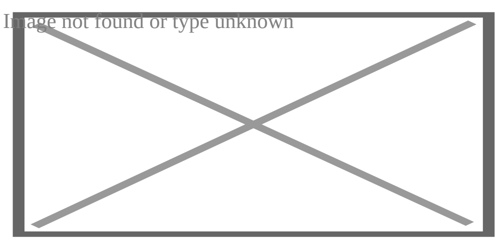
Simplified process flow diagram for a typical large-scale treatment plant using the activated sludge process

The main processes involved in secondary sewage treatment are designed to remove as much of the solid material as possible.[13] They use biological processes to digest and remove the remaining soluble material, especially the organic fraction. This can be done with either suspended-growth or biofilm processes. The microorganisms that feed on the organic matter present in the sewage grow and multiply, constituting the biological solids, or biomass. These grow and group together in the form of flocs or biofilms and, in some specific processes, as granules. The biological floc or biofilm and remaining fine solids form a sludge which can be settled and separated. After separation, a liquid remains that is almost free of solids, and with a greatly reduced concentration of pollutants.[13]

Secondary treatment can reduce organic matter (measured as biological oxygen demand) from sewage,â€Š using aerobic or anaerobic processes. The organisms involved in these processes are sensitive to the presence of toxic materials, although these are not expected to be present at high concentrations in typical municipal sewage.

Tertiary treatment

[edit]



Overall setup for a micro filtration system

Advanced sewage treatment generally involves three main stages, called primary, secondary and tertiary treatment but may also include intermediate stages and final polishing processes. The purpose of tertiary treatment (also called *advanced treatment*) is to provide a final treatment stage to further improve the effluent quality before it is discharged to the receiving water body or reused. More than one tertiary treatment process may be used at any treatment plant. If disinfection is practiced, it is always the final process. It is also called *effluent polishing*. Tertiary treatment may include biological nutrient removal (alternatively, this can be classified as secondary treatment), disinfection and partly removal of micropollutants, such as environmental persistent pharmaceutical pollutants.

Tertiary treatment is sometimes defined as anything more than primary and secondary treatment in order to allow discharge into a highly sensitive or fragile ecosystem such as estuaries, low-flow rivers or coral reefs.[28] Treated water is sometimes disinfected chemically or physically (for example, by lagoons and microfiltration) prior to discharge into a stream, river, bay, lagoon or wetland, or it can be used for the irrigation of a golf course, greenway or park. If it is sufficiently clean, it can also be used for groundwater recharge or agricultural purposes.

Sand filtration removes much of the residual suspended matter.[25]:â€Š22–23â€Š Filtration over activated carbon, also called *carbon adsorption,* removes residual toxins.[25]:â€Š19â€Š Micro filtration or synthetic membranes are used in membrane bioreactors and can also remove pathogens.[7]:â€Š854â€Š

Settlement and further biological improvement of treated sewage may be achieved through storage in large human-made ponds or lagoons. These lagoons are highly aerobic, and colonization by native macrophytes, especially reeds, is often encouraged.

Disinfection

[edit]

Disinfection of treated sewage aims to kill pathogens (disease-causing microorganisms) prior to disposal. It is increasingly effective after more elements of the foregoing treatment sequence have been completed.[29]:â€Š359â€Š The purpose of disinfection in the treatment of sewage is to substantially reduce the number of pathogens in the water to be discharged back into the environment or to be reused. The target level of reduction of biological contaminants like pathogens is often regulated by the presiding governmental authority. The effectiveness of disinfection depends on the quality of the water being treated (e.g. turbidity, pH, etc.), the type of disinfection being used, the disinfectant dosage (concentration and time), and other environmental variables. Water with high turbidity will be treated less successfully, since solid matter can shield organisms, especially from ultraviolet light or if contact times are low. Generally, short contact times, low doses and high flows all militate against effective disinfection. Common methods of disinfection include ozone, chlorine, ultraviolet light, or sodium hypochlorite.[25]:â€Š16â€Š Monochloramine, which is used for drinking water, is not used in the treatment of sewage because of its persistence.

Chlorination remains the most common form of treated sewage disinfection in many countries due to its low cost and long-term history of effectiveness. One disadvantage is that chlorination of residual organic material can generate chlorinated-organic compounds that may be carcinogenic or harmful to the environment. Residual chlorine or chloramines may also be capable of chlorinating organic material in the natural aquatic environment. Further, because residual chlorine is toxic to aquatic species, the treated effluent must also be chemically dechlorinated, adding to the complexity and cost of treatment.

Ultraviolet (UV) light can be used instead of chlorine, iodine, or other chemicals. Because no chemicals are used, the treated water has no adverse effect on organisms that later consume it, as may be the case with other methods. UV radiation causes damage to the genetic structure of bacteria, viruses, and other pathogens, making them incapable of reproduction. The key disadvantages of UV disinfection are the need for frequent lamp maintenance and replacement and the need for a highly treated effluent to ensure that the target microorganisms are not shielded from the UV radiation (i.e., any solids present in the treated effluent may protect microorganisms from the UV light). In many countries, UV light is becoming the most common means of disinfection because of the concerns about the impacts of chlorine in chlorinating residual organics in the treated sewage and in chlorinating organics in the receiving water.

As with UV treatment, heat sterilization also does not add chemicals to the water being treated. However, unlike UV, heat can penetrate liquids that are not transparent. Heat disinfection can also penetrate solid materials within wastewater, sterilizing their contents. Thermal effluent decontamination systems provide low resource, low maintenance effluent decontamination once installed.

Ozone (O_3) is generated by passing oxygen (

O_2) through a high voltage potential resulting in a third oxygen atom becoming attached and forming

O_3. Ozone is very unstable and reactive and oxidizes most organic material it comes in contact with, thereby destroying many pathogenic microorganisms. Ozone is considered to be safer than chlorine because, unlike chlorine which has to be stored on site (highly poisonous in the event of an accidental release), ozone is generated on-site as needed from the oxygen in the ambient air. Ozonation also produces fewer disinfection by-products than chlorination. A disadvantage of ozone disinfection is the high cost of the ozone generation equipment and the requirements for special operators. Ozone sewage treatment requires the use of an ozone generator, which decontaminates the water as ozone bubbles percolate through the tank.

Membranes can also be effective disinfectants, because they act as barriers, avoiding the passage of the microorganisms. As a result, the final effluent may be devoid of pathogenic organisms, depending on the type of membrane used. This principle is applied in membrane bioreactors.

Biological nutrient removal

[edit]

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Nitrification process tank at an activated sludge plant in the United States

Sewage may contain high levels of the nutrients nitrogen and phosphorus. Typical values for nutrient loads per person and nutrient concentrations in raw sewage in developing countries have been published as follows: 8 g/person/d for total nitrogen (45 mg/L), 4.5 g/person/d for ammonia-N (25 mg/L) and 1.0 g/person/d for total phosphorus (7 mg/L).[4]:â€Š57â€Š The typical ranges for these values are: 6–10 g/person/d for total nitrogen (35–60 mg/L), 3.5–6 g/person/d for ammonia-N (20–35 mg/L) and 0.7–2.5 g/person/d for total phosphorus (4–15 mg/L).[4]:â€Š57â€Š

Excessive release to the environment can lead to nutrient pollution, which can manifest itself in eutrophication. This process can lead to algal blooms, a rapid growth, and later decay, in the population of algae. In addition to causing deoxygenation, some algal species produce toxins that contaminate drinking water supplies.

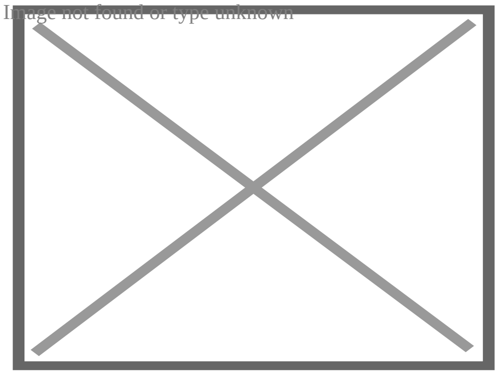
Ammonia nitrogen, in the form of free ammonia (NH_3) is toxic to fish. Ammonia nitrogen, when converted to nitrite and further to nitrate in a water body, in the process of nitrification, is associated with the consumption of dissolved oxygen. Nitrite and nitrate may also have public health significance if concentrations are high in drinking water, because of a disease called metahemoglobinemia.[4]:â€Š42â€Š

Phosphorus removal is important as phosphorus is a limiting nutrient for algae growth in many fresh water systems. Therefore, an excess of phosphorus can lead to eutrophication. It is also particularly important for water reuse systems where high phosphorus concentrations may lead to fouling of downstream equipment such as reverse osmosis.

A range of treatment processes are available to remove nitrogen and phosphorus. Biological nutrient removal (BNR) is regarded by some as a type of secondary treatment process,[7] and by others as a *tertiary* (or *advanced*) treatment process.

Nitrogen removal

[edit]



Constructed wetlands (vertical flow) for sewage treatment near Shanghai, China

Nitrogen is removed through the biological oxidation of nitrogen from ammonia to nitrate (nitrification), followed by denitrification, the reduction of nitrate to nitrogen gas. Nitrogen gas is released to the atmosphere and thus removed from the water.

Nitrification itself is a two-step aerobic process, each step facilitated by a different type of bacteria. The oxidation of ammonia (NH_4^+) to nitrite ($NO_2^?$) is most often facilitated by bacteria such as *Nitrosomonas* spp. (*nitroso* refers to the formation of a nitroso functional group). Nitrite oxidation to nitrate ($NO_3^?$), though traditionally believed to be facilitated by *Nitrobacter* spp. (nitro referring the formation of a nitro functional group), is now known to be facilitated in the environment predominantly by *Nitrospira* spp.

Denitrification requires anoxic conditions to encourage the appropriate biological communities to form. *Anoxic conditions* refers to a situation where oxygen is absent but nitrate is present. Denitrification is facilitated by a wide diversity of bacteria. The activated sludge process, sand filters, waste stabilization ponds, constructed wetlands and other processes can all be used to reduce nitrogen.[25]:â€Š17–18â€Š Since denitrification is the reduction of nitrate to dinitrogen (molecular nitrogen) gas, an electron donor is needed. This can be, depending on the wastewater, organic matter (from the sewage itself), sulfide, or an added donor like methanol. The sludge in the anoxic tanks (denitrification tanks) must be mixed well (mixture of recirculated mixed liquor, return activated sludge, and raw influent) e.g. by using submersible mixers in order to achieve the desired denitrification.

Over time, different treatment configurations for activated sludge processes have evolved to achieve high levels of nitrogen removal. An initial scheme was called the Ludzack–Ettinger Process. It could not achieve a high level of denitrification.[7]:â€Š616â€Š The Modified Ludzak–Ettinger Process (MLE) came later and was an improvement on the original concept. It recycles mixed liquor from the discharge end of the aeration tank to the head of the anoxic tank. This provides nitrate for the facultative bacteria.[7]:â€Š616â€Š

There are other process configurations, such as variations of the Bardenpho process.[30]:â€Š160â€Š They might differ in the placement of anoxic tanks, e.g. before and after the aeration tanks.

Phosphorus removal

[edit]

Studies of United States sewage in the late 1960s estimated mean per capita contributions of 500 grams (18 oz) in urine and feces, 1,000 grams (35 oz) in synthetic detergents, and lesser variable amounts used as corrosion and scale control chemicals in water supplies.[31] Source control via alternative detergent formulations has subsequently reduced the largest contribution, but naturally the phosphorus content of urine and feces remained unchanged.

Phosphorus can be removed biologically in a process called enhanced biological phosphorus removal. In this process, specific bacteria, called polyphosphate-accumulating organisms (PAOs), are selectively enriched and accumulate large quantities of phosphorus within their cells (up to 20 percent of their mass).[30]:â€Š148–155â€Š

Phosphorus removal can also be achieved by chemical precipitation, usually with salts of iron (e.g. ferric chloride) or aluminum (e.g. alum), or lime.[25]:â€Š18â€Š This may lead to a higher sludge production as hydroxides precipitate and the added chemicals can be expensive. Chemical phosphorus removal requires significantly smaller equipment footprint than biological removal, is easier to operate and is often more reliable than biological phosphorus removal. Another method for phosphorus removal is to use granular laterite or zeolite.[32][33]

Some systems use both biological phosphorus removal and chemical phosphorus removal. The chemical phosphorus removal in those systems may be used as a backup system, for use when the biological phosphorus removal is not removing enough phosphorus, or may be used continuously. In either case, using both biological and chemical phosphorus removal has the advantage of not increasing sludge production as much as chemical phosphorus removal on its own, with the disadvantage of the increased initial cost associated with installing two different systems.

Once removed, phosphorus, in the form of a phosphate-rich sewage sludge, may be sent to landfill or used as fertilizer in admixture with other digested sewage sludges. In the latter case, the treated sewage sludge is also sometimes referred to as biosolids. 22% of the world's phosphorus needs could be satisfied by recycling residential wastewater.[34][35]

Fourth treatment stage

[edit]
Further information: Environmental impact of pharmaceuticals and personal care products

Micropollutants such as pharmaceuticals, ingredients of household chemicals, chemicals used in small businesses or industries, environmental persistent pharmaceutical pollutants (EPPP) or pesticides may not be eliminated in the commonly used sewage treatment processes (primary, secondary and tertiary treatment) and therefore lead to water pollution.[36] Although concentrations of those substances and their decomposition products are quite low, there is still a chance of harming aquatic organisms. For pharmaceuticals, the following substances have been identified as toxicologically relevant: substances with endocrine disrupting effects, genotoxic substances and substances that enhance the development of bacterial resistances.[37] They mainly belong to the group of EPPP.

Techniques for elimination of micropollutants via a fourth treatment stage during sewage treatment are implemented in Germany, Switzerland, Sweden[3] and the Netherlands and tests are ongoing in several other countries.[38] In Switzerland it has been enshrined in law since 2016.[39] Since 1 January 2025, there has been a recast of the Urban Waste Water Treatment Directive in the European Union. Due to the large number of amendments that have now been made, the directive was rewritten on November 27, 2024 as Directive (EU) 2024/3019, published in the EU Official Journal on December 12, and entered into force on January 1, 2025. The member states now have 31 months, i.e. until July 31, 2027, to adapt their national legislation to the new directive ("implementation of the directive").

The amendment stipulates that, in addition to stricter discharge values for nitrogen and phosphorus, persistent trace substances must at least be partially separated. The target, similar to Switzerland, is that 80% of 6 key substances out of 12 must be removed between discharge into the sewage treatment plant and discharge into the water body. At least 80% of the investments and operating costs for the fourth treatment stage will be passed on to the pharmaceutical and cosmetics industry according to the polluter pays principle in order to relieve the population financially and provide an incentive for the development of more environmentally friendly products. In addition, the municipal wastewater treatment sector is to be energy neutral by 2045 and the emission of microplastics and PFAS is to be monitored.

The implementation of the framework guidelines is staggered until 2045, depending on the size of the sewage treatment plant and its population equivalents (PE). Sewage treatment plants with over 150,000 PE have priority and should be adapted immediately, as a significant proportion of the pollution comes from them. The adjustments are staggered at national level in:

- 20% of the plants by 31 December 2033,
- 60% of the plants by 31 December 2039,
- 100% of the plants by 31 December 2045.

Wastewater treatment plants with 10,000 to 150,000 PE that discharge into coastal waters or sensitive waters are staggered at national level in:

- 10% of the plants by 31 December 2033,
- 30% of the plants by 31 December 2036,
- 60% of the plants by 31 December 2039,
- 100% of the plants by 31 December 2045.

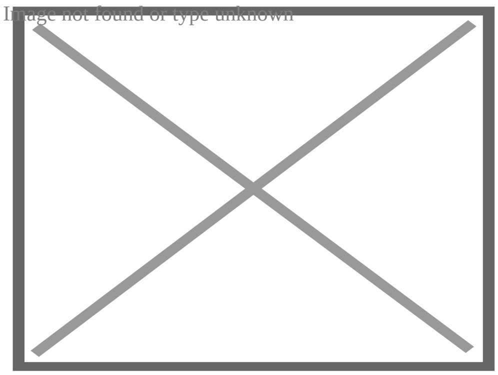
The latter concerns waters with a low dilution ratio, waters from which drinking water is obtained and those that are coastal waters, or those used as bathing waters or used for mussel farming. Member States will be given the option not to apply fourth treatment in these areas if a risk assessment shows that there is no potential risk from micropollutants to human health and/or the environment.[40][41]

Such process steps mainly consist of activated carbon filters that adsorb the micropollutants. The combination of advanced oxidation with ozone followed by granular activated carbon (GAC) has been suggested as a cost-effective treatment combination for pharmaceutical residues. For a full reduction of microplasts the combination of ultrafiltration followed by GAC has been suggested. Also the use of enzymes such as laccase secreted by fungi is under investigation.[42][43] Microbial biofuel cells are investigated for their property to treat organic matter in sewage.[44]

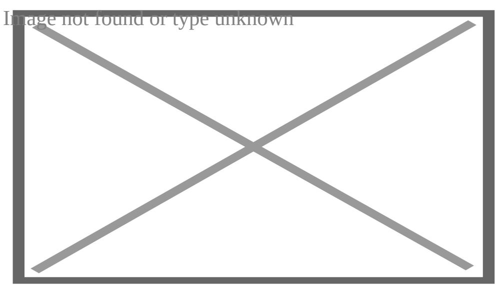
To reduce pharmaceuticals in water bodies, source control measures are also under investigation, such as innovations in drug development or more responsible handling of drugs.[37][45] In the US, the National Take Back Initiative is a voluntary program with the general public, encouraging people to return excess or expired drugs, and avoid flushing them to the sewage system.[46]

Sludge treatment and disposal

[edit]



View of a belt filter press at the Blue Plains Advanced Wastewater Treatment Plant, Washington, D.C.



Mechanical dewatering of sewage sludge with a centrifuge at a large sewage treatment plant (Arrudas Treatment Plant, Belo Horizonte, Brazil)

This section is an excerpt from Sewage sludge treatment. [edit]

Sewage sludge treatment describes the processes used to manage and dispose of sewage sludge produced during sewage treatment. Sludge treatment is focused on reducing sludge weight and volume to reduce transportation and disposal costs, and on reducing potential health risks of disposal options. Water removal is the primary means of weight and volume reduction, while pathogen destruction is frequently accomplished through heating during thermophilic digestion, composting, or incineration. The choice of a sludge treatment method depends on the volume of sludge generated, and comparison of treatment costs required for available disposal options. Air-drying and composting may be attractive to rural communities, while limited land availability may make aerobic digestion and mechanical dewatering preferable for cities, and economies of scale may encourage energy recovery alternatives in metropolitan areas.

Sludge is mostly water with some amounts of solid material removed from liquid sewage. Primary sludge includes settleable solids removed during primary treatment in primary clarifiers. Secondary sludge is sludge separated in secondary clarifiers that are used in secondary treatment bioreactors or processes using inorganic oxidizing agents. In intensive sewage treatment processes, the sludge produced needs to be removed from the liquid line on a continuous basis because the volumes of the tanks in the liquid line have insufficient volume to store sludge.[47] This is done in order to keep the treatment processes compact and in balance (production of sludge approximately equal to the removal of sludge). The sludge removed from the liquid line goes to the sludge treatment line. Aerobic processes (such as the activated sludge process) tend to produce more sludge compared with anaerobic processes. On the other hand, in extensive (natural) treatment processes, such as ponds and constructed wetlands, the produced sludge remains accumulated in the treatment units (liquid line) and is only removed after several years of operation.[48]

Sludge treatment options depend on the amount of solids generated and other site-specific conditions. Composting is most often applied to small-scale plants with aerobic digestion for mid-sized operations, and anaerobic digestion for the larger-scale operations. The sludge is sometimes passed through a so-called pre-thickener which de-waters the sludge. Types of pre-thickeners include centrifugal sludge thickeners,[49] rotary drum sludge thickeners and belt filter presses.[50] Dewatered sludge may be incinerated or transported offsite for disposal in a landfill or use as an agricultural soil amendment.[51]

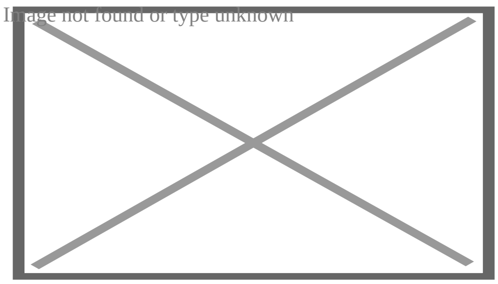
Environmental impacts

[edit]

Sewage treatment plants can have significant effects on the biotic status of receiving waters and can cause some water pollution, especially if the treatment process used is only basic. For example, for sewage treatment plants without nutrient removal, eutrophication of receiving water bodies can be a problem.

This section is an excerpt from Water pollution.[edit]

Water pollution (or aquatic pollution) is the contamination of water bodies, with a negative impact on their uses.[52]:â€Š6â€Š It is usually a result of human activities. Water bodies include lakes, rivers, oceans, aquifers, reservoirs and groundwater. Water pollution results when contaminants mix with these water bodies. Contaminants can come from one of four main sources. These are sewage discharges, industrial activities, agricultural activities, and urban runoff including stormwater.[53] Water pollution may affect either surface water or groundwater. This form of pollution can lead to many problems. One is the degradation of aquatic ecosystems. Another is spreading water-borne diseases when people use polluted water for drinking or irrigation.[54] Water pollution also reduces the ecosystem services such as drinking water provided by the water resource.



Treated effluent from sewage treatment plant in DÄ›Ä•ín, Czech Republic, is discharged to surface waters.

In 2024, The Royal Academy of Engineering released a study into the effects wastewater on public health in the United Kingdom.[55] The study gained media attention, with comments from the UKs leading health professionals, including Sir Chris Whitty. Outlining 15 recommendations for various UK bodies to dramatically reduce public health risks by increasing the water quality in its waterways, such as rivers and lakes.

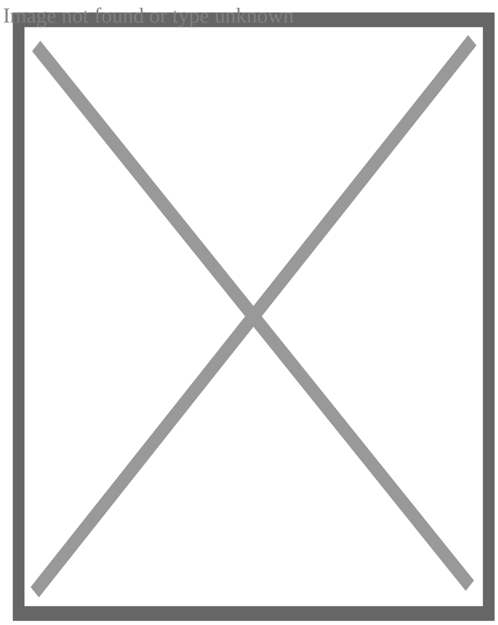
After the release of the report, The Guardian newspaper interviewed Whitty, who stated that improving water quality and sewage treatment should be a high level of importance and a "public health priority". He compared it to eradicating cholera in the 19th century in the country following improvements to the sewage treatment network.[56] The study also identified that low water flows in rivers saw high concentration levels of sewage, as well as times of flooding or heavy rainfall. While heavy rainfall had always been associated with sewage overflows into streams and rivers, the British media went as far to warn parents of the dangers of paddling in shallow rivers during warm weather.[57]

Whitty's comments came after the study revealed that the UK was experiencing a growth in the number of people that were using coastal and inland waters recreationally. This could be connected to a growing interest in activities such as open water swimming or other water sports.[58] Despite this growth in recreation, poor water quality meant some were becoming unwell during events.[59] Most notably, the 2024 Paris Olympics had to delay numerous swimming-focused events like the triathlon due to high levels of sewage in the River Seine.[60]

Reuse

[edit]

Further information: Reuse of excreta

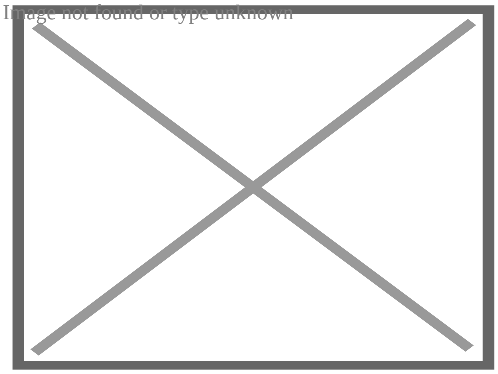


Sludge drying beds for sewage sludge treatment at a small treatment plant at the Center for Research and Training in Sanitation, Belo Horizonte, Brazil

Irrigation

[edit]
See also: Sewage farm

Increasingly, people use treated or even untreated sewage for irrigation to produce crops. Cities provide lucrative markets for fresh produce, so are attractive to farmers. Because agriculture has to compete for increasingly scarce water resources with industry and municipal users, there is often no alternative for farmers but to use water polluted with sewage directly to water their crops. There can be significant health hazards related to using water loaded with pathogens in this way. The World Health Organization developed guidelines for safe use of wastewater in 2006.[61] They advocate a 'multiple-barrier' approach to wastewater use, where farmers are encouraged to adopt various risk-reducing behaviors. These include ceasing irrigation a few days before harvesting to allow pathogens to die off in the sunlight, applying water carefully so it does not contaminate leaves likely to be eaten raw, cleaning vegetables with disinfectant or allowing fecal sludge used in farming to dry before being used as a human manure.[62]



Circular secondary sedimentation tank at activated sludge sewage treatment plant at Arrudas Treatment Plant, Belo Horizonte, Brazil

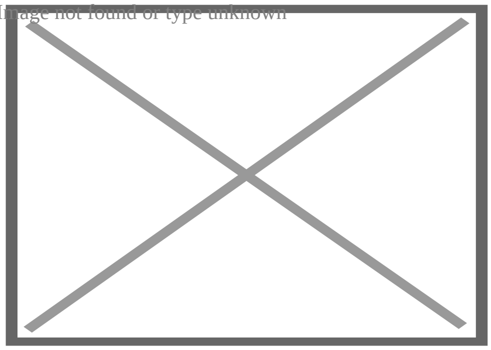
Reclaimed water

[edit]

This section is an excerpt from Reclaimed water. [edit]
Water reclamation is the process of converting municipal wastewater or sewage and industrial wastewater into water that can be reused for a variety of purposes. It is also called wastewater reuse, water reuse or water recycling. There are many types of reuse. It is possible to reuse water in this way in cities or for irrigation in agriculture. Other types of reuse are environmental reuse, industrial reuse, and reuse for drinking water, whether planned or not. Reuse may include irrigation of gardens and agricultural fields or replenishing surface water and groundwater. This latter is also known as groundwater recharge. Reused water also serve various needs in residences such as toilet flushing, businesses, and industry. It is possible to treat wastewater to reach drinking water standards. Injecting reclaimed water into the water supply distribution system is known as direct potable reuse. Drinking reclaimed water is not typical.[63] Reusing treated municipal wastewater for irrigation is a long-established practice. This is especially so in arid countries. Reusing wastewater as part of sustainable water management allows water to remain an alternative water source for human activities. This can reduce scarcity. It also eases pressures on groundwater and other natural water bodies.[64]

Global situation

[edit]



Share of domestic wastewater that is safely treated (in 2018) [65]

Before the 20th century in Europe, sewers usually discharged into a body of water such as a river, lake, or ocean. There was no treatment, so the breakdown of the human waste was left to the ecosystem. This could lead to satisfactory results if the assimilative capacity of the ecosystem is sufficient which is nowadays not often the case due to increasing population density. [4]:â€Š78â€Š

Today, the situation in urban areas of industrialized countries is usually that sewers route their contents to a sewage treatment plant rather than directly to a body of water. In many developing countries, however, the bulk of municipal and industrial wastewater is discharged to rivers and the ocean without any treatment or after preliminary treatment or primary treatment only. Doing so can lead to water pollution. Few reliable figures exist on the share of the wastewater collected in sewers that is being treated worldwide. A global estimate by UNDP and UN-Habitat in 2010 was that 90% of all wastewater generated is released into the environment untreated. [66] A more recent study in 2021 estimated that globally, about 52% of sewage is treated. [5] However, sewage treatment rates are highly unequal for different countries around the world. For example, while high-income countries treat approximately 74% of their sewage, developing countries treat an average of just 4.2%. [5] As of 2022, without sufficient treatment, more than 80% of all wastewater generated globally is released into the environment. High-income nations treat, on average, 70% of the wastewater they produce, according to UN Water. [34][67][68] Only 8% of wastewater produced in low-income nations receives any sort of treatment. [34][69][70]

The Joint Monitoring Programme (JMP) for Water Supply and Sanitation by WHO and UNICEF report in 2021 that 82% of people with sewer connections are connected to sewage treatment plants providing at least secondary treatment. [71]:â€Š55â€Š However, this value varies widely between regions. For example, in Europe, North America, Northern Africa and Western Asia, a total of 31 countries had universal (>99%) wastewater treatment. However, in Albania, Bermuda, North Macedonia and Serbia "less than 50% of sewered wastewater received secondary or better treatment" and in Algeria, Lebanon and Libya the value was less than 20% of sewered wastewater that was being treated. The report also found that "globally, 594 million people have sewer connections that don't receive sufficient treatment. Many more are connected to wastewater treatment plants that do not provide effective treatment or comply with effluent requirements.".[71]:â€Š55â€Š

Global targets

[edit]

Sustainable Development Goal 6 has a Target 6.3 which is formulated as follows: "By 2030, improve water quality by reducing pollution, eliminating,dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally."[65] The corresponding Indicator 6.3.1 is the "proportion of wastewater safely treated". It is anticipated that wastewater production would rise by 24% by 2030 and by 51% by 2050.[34][72][73]

Data in 2020 showed that there is still too much uncollected household wastewater: Only 66% of all household wastewater flows were collected at treatment facilities in 2020 (this is determined from data from 128 countries).[8]:â€Š17â€Š Based on data from 42 countries in 2015, the report stated that "32 per cent of all wastewater flows generated from point sources received at least some treatment".[8]:â€Š17â€Š For sewage that has indeed been collected at centralized sewage treatment plants, about 79% went on to be safely treated in 2020.[8]:â€Š18â€Š

History

[edit]
Further information: History of water supply and sanitation § Sewage treatment

The history of sewage treatment had the following developments: It began with land application (sewage farms) in the 1840s in England, followed by chemical treatment and sedimentation of sewage in tanks, then biological treatment in the late 19th century, which led to the development of the activated sludge process starting in 1912.[74][75]

This section is an excerpt from History of water supply and sanitation § Biological treatment.[edit]

It was not until the late 19th century that it became possible to treat the sewage by biologically decomposing the organic components through the use of microorganisms and removing the pollutants. Land treatment was also steadily becoming less feasible, as cities grew and the volume of sewage produced could no longer be absorbed by the farmland on the outskirts.

Edward Frankland conducted experiments at the sewage farm in Croydon, England during the 1870s and was able to demonstrate that filtration of sewage through porous gravel produced a nitrified effluent (the ammonia was converted into nitrate) and that the filter remained unclogged over long periods of time.[76] This established the then revolutionary possibility of biological treatment of sewage using a contact bed to oxidize the waste. This concept was taken up by the chief chemist for the London Metropolitan Board of Works, William Dibdin, in 1887:

> ...in all probability the true way of purifying sewage...will be first to separate the sludge, and then turn into neutral effluent... retain it for a sufficient period, during which time it should be fully aerated, and finally discharge it into the stream in a purified condition. This is indeed what is aimed at and imperfectly accomplished on a sewage farm.[77]

From 1885 to 1891, filters working on Dibdin's principle were constructed throughout the UK and the idea was also taken up in the US at the Lawrence Experiment Station in Massachusetts, where Frankland's work was confirmed.[78] In 1890, the LES developed a 'trickling filter' that gave a much more reliable performance.[79]

Regulations

[edit]

In most countries, sewage collection and treatment are subject to local and national regulations and standards.

By country

[edit]

Overview

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Wastewater treatment by country

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Europe

[edit]

In the European Union, 0.8% of total energy consumption goes to wastewater treatment facilities.[34][80] The European Union needs to make extra investments of €90 billion in the water and waste sector to meet its 2030 climate and energy goals.[34][81][82]

In October 2021, British Members of Parliament voted to continue allowing untreated sewage from combined sewer overflows to be released into waterways.[83][84]

This section is an excerpt from Urban Waste Water Treatment Directive § Description.[edit]
The Urban Waste Water Treatment Directive (full title "Council Directive 91/271/EEC of 21 May 1991 concerning urban waste-water treatment") is a European Union directive regarding urban wastewater collection, wastewater treatment and its discharge, as well as the treatment and discharge of "waste water from certain industrial sectors". It was adopted on 21 May 1991.[85] It aims "to protect the environment from the adverse effects of urban waste water discharges and discharges from certain industrial sectors" by mandating waste water collection and treatment in urban agglomerations with a population equivalent of over 2000, and more advanced treatment in places with a population equivalent above 10,000 in sensitive areas.[86]

Asia

[edit]

India

[edit]

This section is an excerpt from Water supply and sanitation in India § Wastewater treatment.[edit]

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Picture of a wastewater stream

In India, wastewater treatment regulations come under three central institutions, the ministries of forest, climate change housing, urban affairs and water.[87] The various water and sanitation policies such as the "National Environment Policy 2006" and "National Sanitation Policy 2008" also lay down wastewater treatment regulations. State governments and local municipalities hold responsibility for the disposal of sewage and construction and maintenance of "sewerage infrastructure". Their efforts are supported by schemes offered by the Government of India, such as the National River Conservation Plan, Jawaharlal Nehru National Urban Renewal Mission, National Lake Conservation Plan. Through the Ministry of Environment and Forest, India's government also has set up incentives that encourage industries to establish "common facilities" to undertake the treatment of wastewater.[88]

The 'Delhi Jal Board' (DJB) is currently operating on the construction of the largest sewage treatment plant in India. It will be operational by the end of 2022 with an estimated capacity of 564 MLD. It is supposed to solve the existing situation wherein untreated sewage water is being discharged directly into the river 'Yamuna'.

Japan

[edit]

This section is an excerpt from Water supply and sanitation in Japan § Wastewater treatment and sanitation.[edit]
Currently, Japan's methods of wastewater treatment include rural community sewers, wastewater facilities, and on-site treatment systems such as the Johkasou system to treat domestic wastewater.[89] Larger wastewater facilities and sewer systems are generally used to treat wastewater in more urban areas with a larger population. Rural sewage systems are used to treat wastewater at smaller domestic wastewater treatment plants for a smaller population. Johkasou systems are on-site wastewater treatment systems tanks. They are used to treat the wastewater of a single household or to treat the wastewater of a small number of buildings in a more decentralized

manner than a sewer system.[90]

Africa

[edit]

Libya

[edit]

This section is an excerpt from Environmental issues in Libya § Wastewater treatment.[edit]

In Libya, municipal wastewater treatment is managed by the general company for water and wastewater in Libya, which falls within the competence of the Housing and Utilities Government Ministry. There are approximately 200 sewage treatment plants across the nation, but few plants are functioning. In fact, the 36 larger plants are in the major cities; however, only nine of them are operational, and the rest of them are under repair.[91]

The largest operating wastewater treatment plants are situated in Sirte, Tripoli, and Misurata, with a design capacity of 21,000, 110,000, and 24,000 m3/day, respectively. Moreover, a majority of the remaining wastewater facilities are small and medium-sized plants with a design capacity of approximately 370 to 6700 m3/day. Therefore, 145,800 m3/day or 11 percent of the wastewater is actually treated, and the remaining others are released into the ocean and artificial lagoons although they are untreated. In fact, nonoperational wastewater treatment plants in Tripoli lead to a spill of over 1,275, 000 cubic meters of unprocessed water into the ocean every day.[91]

Americas

[edit]

United States

[edit]

This section is an excerpt from Water supply and sanitation in the United States § Wastewater treatment.[edit]

The United States Environmental Protection Agency (EPA) and state environmental agencies set wastewater standards under the Clean Water Act.[92] Point sources must obtain surface water discharge permits through the National Pollutant Discharge Elimination System (NPDES). Point sources include industrial facilities, municipal governments (sewage treatment plants and storm sewer systems), other government facilities such as military bases, and some agricultural facilities, such as animal feedlots.[93] EPA sets basic national wastewater standards: The "Secondary Treatment Regulation" applies to municipal sewage treatment plants,[94] and the "Effluent guidelines" which are regulations for categories of industrial facilities.[95]

See also

[edit]

- icon Image not found or type unknown Environment portal
- Decentralized wastewater system
- List of largest wastewater treatment plants
- List of water supply and sanitation by country
- Organisms involved in water purification
- Sanitary engineering
- Waste disposal

References

[edit]

1. ^ ***a b c*** *"Sanitation Systems – Sanitation Technologies – Activated sludge". SSWM. 27 April 2018. Retrieved 31 October 2018.*
2. **^** *Khopkar, S.M. (2004). Environmental Pollution Monitoring And Control. New Delhi: New Age International. p. 299. ISBN 978-81-224-1507-0.*
3. ^ ***a b c*** *Takman, Maria; Svahn, Ola; Paul, Catherine; Cimbritz, Michael; Blomqvist, Stefan; Struckmann Poulsen, Jan; Lund Nielsen, Jeppe; Davidsson, Åsa (15 October 2023). "Assessing the potential of a membrane bioreactor and granular activated carbon process for wastewater reuse – A full-scale WWTP operated over one year in Scania, Sweden". Science of the Total Environment.* ***895****: 165185. Bibcode:2023ScTEn.89565185T. doi: 10.1016/j.scitotenv.2023.165185. ISSN 0048-9697. PMID 37385512. S2CID 259296091.*
4. ^ ***a b c d e f g h i j k l m n o p q*** *Von Sperling, M. (2007). "Wastewater Characteristics, Treatment and Disposal". Water Intelligence Online.* ***6****. doi: 10.2166/9781780402086. ISSN 1476-1777.* Image not found or type unknown Text was copied from this source, which is available under a Creative Commons Attribution 4.0 International License
5. ^ ***a b c d*** *Jones, Edward R.; van Vliet, Michelle T. H.; Qadir, Manzoor; Bierkens, Marc F. P. (2021). "Country-level and gridded estimates of wastewater production, collection, treatment and reuse". Earth System Science Data.* ***13*** *(2):*

237–254. Bibcode:2021ESSD...13..237J. doi:10.5194/essd-13-237-2021. ISSN 1866-3508.
6. **^** "Sanitation". *Health topics*. World Health Organization. Retrieved 23 February 2020.
7. ^ ***a b c d e f g h i j k l m n o p*** George Tchobanoglous; H. David Stensel; Ryujiro Tsuchihashi; Franklin L. Burton; Mohammad Abu-Orf; Gregory Bowden, eds. (2014). *Metcalf & Eddy Wastewater Engineering: Treatment and Resource Recovery* (5th ed.). New York: McGraw-Hill Education. ISBN 978-0-07-340118-8. OCLC 858915999.
8. ^ ***a b c d*** UN-Water, 2021: Summary Progress Update 2021 – SDG 6 – water and sanitation for all. Version: July 2021. Geneva, Switzerland
9. **^** WWAP (United Nations World Water Assessment Programme) (2017). *The United Nations World Water Development Report 2017. Wastewater: The Untapped Resource*. UNESCO. ISBN 978-92-3-100201-4. Archived from the original on 8 April 2017.
10. ^ ***a b*** Von Sperling, M. (2007). "Wastewater Characteristics, Treatment and Disposal". *Water Intelligence Online*. **6**. doi:10.2166/9781780402086. ISBN 978-1-78040-208-6. ISSN 1476-1777. Image not found or type unknown Text was copied from this source, which is available under a Creative Commons Attribution 4.0 International License
11. **^** Henze, M.; van Loosdrecht, M. C. M.; Ekama, G.A.; Brdjanovic, D. (2008). *Biological Wastewater Treatment: Principles, Modelling and Design*. IWA Publishing. doi:10.2166/9781780401867. ISBN 978-1-78040-186-7. S2CID 108595515. Spanish and Arabic versions available free online
12. ^ ***a b*** Tilley E, Ulrich L, Lüthi C, Reymond P, Zurbrügg C (2014). *Compendium of Sanitation Systems and Technologies* (2nd Revised ed.). Duebendorf, Switzerland: Swiss Federal Institute of Aquatic Science and Technology (Eawag). ISBN 978-3-906484-57-0. Archived from the original on 8 April 2016.
13. ^ ***a b c d*** Henze, M.; van Loosdrecht, M. C. M.; Ekama, G.A.; Brdjanovic, D. (2008). *Biological Wastewater Treatment: Principles, Modelling and Design*. IWA Publishing. doi:10.2166/9781780401867. ISBN 978-1-78040-186-7. S2CID 108595515. (Spanish and Arabic versions are available online for free)
14. **^** Spuhler, Dorothee; Germann, Verena; Kassa, Kinfe; Ketema, Atekelt Abebe; Sherpa, Anjali Manandhar; Sherpa, Mingma Gyalzen; Maurer, Max; Lüthi, Christoph; Langergraber, Guenter (2020). "Developing sanitation planning options: A tool for systematic consideration of novel technologies and systems". *Journal of Environmental Management*. **271**: 111004. Bibcode:2020JEnvM.27111004S. doi:10.1016/j.jenvman.2020.111004. hdl:20.500.11850/428109. PMID 32778289. S2CID 221100596.
15. **^** Spuhler, Dorothee; Scheidegger, Andreas; Maurer, Max (2020). "Comparative analysis of sanitation systems for resource recovery: Influence of configurations and single technology components". *Water Research*. **186**: 116281. Bibcode:2020WatRe.18616281S. doi:10.1016/j.watres.2020.116281. PMID 32949886. S2CID 221806742.

16. **^** *Harshman, Vaughan; Barnette, Tony (28 December 2000). "Wastewater Odor Control: An Evaluation of Technologies". Water Engineering & Management. ISSN 0273-2238.*
17. **^** Walker, James D. and Welles Products Corporation (1976)."Tower for removing odors from gases." U.S. Patent No. 4421534.
18. **^** *Sercombe, Derek C. W. (April 1985). "The control of septicity and odours in sewerage systems and at sewage treatment works operated by Anglian Water Services Limited". Water Science & Technology.* ***31*** *(7): 283–292. doi:10.2166/wst.1995.0244.*
19. **^** Hoffmann, H., Platzer, C., von Münch, E., Winker, M. (2011). Technology review of constructed wetlands – Subsurface flow constructed wetlands for greywater and domestic wastewater treatment. Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, Eschborn, Germany, p. 11
20. **^** *Galvão, A; Matos, J; Rodrigues, J; Heath, P (1 December 2005). "Sustainable sewage solutions for small agglomerations". Water Science & Technology.* ***52*** *(12): 25–32. Bibcode:2005WSTec..52R..25G. doi:10.2166/wst.2005.0420. PMID 16477968. Retrieved 27 March 2021.*
21. **^** *"Wastewater Treatment Plant - Operator Certification Training - Module 20:Trickling Filter" (PDF). Pennsylvania Department of Environmental Protection. 2016. Retrieved 27 March 2021.*
22. **^** Chowdhry, S., Koné, D. (2012). Business Analysis of Fecal Sludge Management: Emptying and Transportation Services in Africa and Asia – Draft final report. Bill & Melinda Gates Foundation, Seattle, US
23. **^** U.S. Environmental Protection Agency, Washington, D.C. (2008). "Septic Systems Fact Sheet." Archived 12 April 2013 at the Wayback Machine EPA publication no. 832-F-08-057.
24. **^** Water and Environmental Health at London and Loughborough (1999). "Waste water Treatment Options." Archived 2011-07-17 at the Wayback Machine Technical brief no. 64. London School of Hygiene & Tropical Medicine and Loughborough University.
25. ^ ***a b c d e f g*** EPA. Washington, DC (2004). "Primer for Municipal Waste water Treatment Systems." Document no. EPA 832-R-04-001.
26. **^** *"Chapter 3. Flow Equalization". Process Design Manual for Upgrading Existing Wastewater Treatment Plants (Report). EPA. October 1971.*
27. **^** *"How Wastewater Treatment Works...The Basics" (PDF). EPA. 1998. Archived from the original (PDF) on 5 June 2024. Retrieved 27 March 2021.*
28. **^** *"Stage 3 - Tertiary treatment". Sydney Water. 2010. Retrieved 27 March 2021.*
29. **^** *Metcalf & Eddy, Inc. (1972). Wastewater Engineering. New York: McGraw-Hill. ISBN 978-0-07-041675-8.*
30. ^ ***a b*** *Von Sperling, M. (30 December 2015). "Activated Sludge and Aerobic Biofilm Reactors". Water Intelligence Online.* ***6****: 9781780402123. doi: 10.2166/9781780402123. ISSN 1476-1777.*

31. **^** *Process Design Manual for Phosphorus Removal (Report). EPA. 1976. pp. 2–1. EPA 625/1-76-001a.*
32. **^** *Wood, R. B.; McAtamney, C.F. (December 1996). "Constructed wetlands for waste water treatment: the use of laterite in the bed medium in phosphorus and heavy metal removal". Hydrobiologia.* ***340*** *(1–3): 323–331. Bibcode:1996HyBio.340..323W. doi:10.1007/BF00012776. S2CID 6182870.*
33. **^** *Wang, Shaobin; Peng, Yuelian (9 October 2009). "Natural zeolites as effective adsorbents in water & wastewater treatment" (PDF). Chemical Engineering Journal.* ***156*** *(1): 11–24. doi:10.1016/j.cej.2009.10.029. Retrieved 13 July 2019.*
34. ^ ***a b c d e f*** *"Wastewater resource recovery can fix water insecurity and cut carbon emissions". European Investment Bank. Retrieved 29 August 2022.*
35. **^** *"Is wastewater the new black gold?". Africa Renewal. 10 April 2017. Retrieved 29 August 2022.*
36. **^** UBA (Umweltbundesamt) (2014): Maßnahmen zur Verminderung des Eintrages von Mikroschadstoffen in die Gewässer. Texte 85/2014 (in German)
37. ^ ***a b*** Walz, A., Götz, K. (2014): Arzneimittelwirkstoffe im Wasserkreislauf. ISOE-Materialien zur Sozialen Ökologie Nr. 36 (in German)
38. **^** *Borea, Laura; Ensano, Benny Marie B.; Hasan, Shadi Wajih; Balakrishnan, Malini; Belgiorno, Vincenzo; de Luna, Mark Daniel G.; Ballesteros, Florencio C.; Naddeo, Vincenzo (November 2019). "Are pharmaceuticals removal and membrane fouling in electromembrane bioreactor affected by current density?". Science of the Total Environment.* ***692****: 732–740. Bibcode:2019ScTEn.692..732B. doi:10.1016/j.scitotenv.2019.07.149. PMID 31539981.*
39. **^** The publication platform of federal law of Swiss: *Verordnung des UVEK zur Überprüfung des Reinigungseffekts von Maßnahmen zur Elimination von organischen Spurenstoffen bei Abwasserreinigungsanlagen,* 1. December 2016 (in German)
40. **^** EUR-LEX - Directive of the European Parliament and of the Council Concerning Urban Wastewater Treatment (Recast)
41. **^** EUR-LEX - Directive (EU) 2024/3019 of the European Parliament and of the Council of 27 November 2024 concerning urban wastewater treatment (recast) (Text with EEA relevance)
42. **^** *Margot, J.; et al. (2013). "Bacterial versus fungal laccase: potential for micropollutant degradation". AMB Express.* ***3*** *(1): 63. doi:10.1186/2191-0855-3-63. PMC 3819643. PMID 24152339.*
43. **^** *Heyl, Stephanie (13 October 2014). "Crude mushroom solution to degrade micropollutants and increase the performance of biofuel cells". Bioeconomy BW. Stuttgart: Biopro Baden-Württemberg.*
44. **^** *Logan, B.; Regan, J. (2006). "Microbial Fuel Cells—Challenges and Applications". Environmental Science & Technology.* ***40*** *(17): 5172–5180. Bibcode:2006EnST...40.5172L. doi:10.1021/es0627592. PMID 16999086.*

45. **^** *Lienert, J.; Bürki, T.; Escher, B.I. (2007). "Reducing micropollutants with source control: Substance flow analysis of 212 pharmaceuticals in faeces and urine". Water Science & Technology*. ***56*** *(5): 87–96. Bibcode:2007WSTec..56...87L. doi:10.2166/wst.2007.560. PMID 17881841.*
46. **^** *"National Prescription Drug Take Back Day". Washington, D.C.: U.S. Drug Enforcement Administration. Retrieved 13 June 2021.*
47. **^** *Henze, M.; van Loosdrecht, M.C.M.; Ekama, G.A.; Brdjanovic, D. (2008). Biological Wastewater Treatment: Principles, Modelling and Design*. *IWA Publishing. doi:10.2166/9781780401867. ISBN 978-1-78040-186-7. S2CID 108595515.* (Spanish and Arabic versions are available online for free)
48. **^** *Von Sperling, M. (2015). "Wastewater Characteristics, Treatment and Disposal". Water Intelligence Online*. ***6***: *9781780402086. doi:10.2166/9781780402086. ISSN 1476-1777.*
49. **^** *"Centrifuge Thickening and Dewatering. Fact sheet". EPA. September 2000. EPA 832-F-00-053.*
50. **^** *"Belt Filter Press. Fact sheet". Biosolids. EPA. September 2000. EPA 832-F-00-057.*
51. **^** *Panagos, Panos; Ballabio, Cristiano; Lugato, Emanuele; Jones, Arwyn; Borrelli, Pasquale; Scarpa, Simone; Orgiazzi, Albert o; Montanarella, Luca (9 July 2018). "Potential Sources of Anthropogenic Copper Inputs to European Agricultural Soils". Sustainability*. ***10*** *(7): 2380. Bibcode:2018Sust...10.2380P. doi:10.3390/su10072380. ISSN 2071-1050.*
52. **^** *Von Sperling, Marcos (2007). "Wastewater Characteristics, Treatment and Disposal". Water Intelligence Online. Biological Wastewater Treatment.* ***6***. *IWA Publishing. doi:10.2166/9781780402086. ISBN 978-1-78040-208-6.*
53. **^** *Eckenfelder Jr WW (2000). Kirk-Othmer Encyclopedia of Chemical Technology*. *John Wiley & Sons. doi:10.1002/0471238961.1615121205031105.a01. ISBN 978-0-471-48494-3.*
54. **^** *"Water Pollution". Environmental Health Education Program*. *Cambridge, MA: Harvard T.H. Chan School of Public Health. 23 July 2013. Archived from the original on 18 September 2021. Retrieved 18 September 2021.*
55. **^** *"Testing the waters Priorities for mitigating health risks from wastewater pollution" (PDF). Royal Academy of Engineering. May 2024.*
56. **^** *Laville, Sandra (21 May 2024). "Reducing sewage in rivers and seas is public health priority, says Chris Whitty". The Guardian.*
57. **^** *Blakely, Rhys. "Paddling in rivers this summer could make children ill, warns Whitty". The Times.*
58. **^** *Speare-Cole, Rebecca (20 May 2024). "Minimising sewage in UK waters is a 'public health priority' – Chris Whitty". The Independent.*
59. **^** *"Dozens of triathletes left severely ill after swimming in River Thames". The Independent. 13 June 2024.*
60. **^** *"What's the problem with swimming in the Seine?". BBC. 29 July 2024.*

61. **^** WHO (2006). WHO Guidelines for the Safe Use of Wastewater, Excreta and Greywater – Volume IV: Excreta and greywater use in agriculture Archived 17 October 2014 at the Wayback Machine. World Health Organization (WHO), Geneva, Switzerland
62. **^** Wastewater use in agriculture: *Not only an issue where water is scarce!* Archived 2014-04-09 at the Wayback Machine International Water Management Institute, 2010. Water Issue Brief 4
63. **^** *Tuser, Cristina (24 May 2022). "What is potable reuse?". Wastewater Digest. Retrieved 29 August 2022.*
64. **^** Andersson, K., Rosemarin, A., Lamizana, B., Kvarnström, E., McConville, J., Seidu, R., Dickin, S. and Trimmer, C. (2016). Sanitation, Wastewater Management and Sustainability: from Waste Disposal to Resource Recovery. Nairobi and Stockholm: United Nations Environment Programme and Stockholm Environment Institute. ISBN 978-92-807-3488-1
65. ^ ***a b*** Ritchie, Roser, Mispy, Ortiz-Ospina (2018) "Measuring progress towards the Sustainable Development Goals." (SDG 6) *SDG-Tracker.org, website*
66. **^** *Corcoran E, Nellemann C, Baker E, Bos R, Osborn D, Savelli M, eds. (2010). Sick water? : the central role of wastewater management in sustainable development: a rapid response assessment (PDF). Arendal, Norway: UNEP/GRID-Arendal. ISBN 978-82-7701-075-5. Archived from the original (PDF) on 18 December 2015. Retrieved 26 December 2014.*
67. **^** *UN-Water. "Quality and Wastewater". UN-Water. Retrieved 29 August 2022.*
68. **^** *"Water and Sanitation". United Nations Sustainable Development. Retrieved 29 August 2022.*
69. **^** *"Only 8 per cent of wastewater in low-income countries undergoes treatment: UN". Retrieved 29 August 2022.*
70. **^** *"50% global wastewater treatment still not enough". www.aquatechtrade.com. Retrieved 29 August 2022.*
71. ^ ***a b*** WHO and UNICEF (2021) Progress on household drinking water, sanitation and hygiene 2000-2020: Five years into the SDGs. Geneva: World Health Organization (WHO) and the United Nations Children's Fund (UNICEF), 2021. Licence: CC BY-NC-SA 3.0 IGO
72. **^** *"Water Scarce Countries: Present and Future". World Data Lab. 15 October 2019. Retrieved 29 August 2022.*
73. **^** *Water and climate change (in Arabic, English, Spanish, French, and Italian). Paris: UNESCO. 2020. ISBN 978-92-3-100371-4. Retrieved 20 June 2023.*
74. **^** *P.F. Cooper. "Historical aspects of wastewater treatment" (PDF). Archived from the original (PDF) on 11 May 2011. Retrieved 21 December 2013.*
75. **^** *Benidickson, Jamie (2011). The Culture of Flushing: A Social and Legal History of Sewage. UBC Press. ISBN 9780774841382. Archived from the original on 19 April 2021. Retrieved 7 February 2013.*
76. **^** *Colin A. Russell (2003). Edward Frankland: Chemistry, Controversy and Conspiracy in Victorian England. Cambridge University Press. pp. 372–380.*

ISBN 978-0-521-54581-5.

77. **^** *Sharma, Sanjay Kumar; Sanghi, Rashmi (2012). Advances in Water Treatment and Pollution Prevention. Springer Science & Business Media. ISBN 978-94-007-4204-8.*
78. **^** *Hamlin, Christopher (1988). "William Dibdin and the Idea of Biological Sewage Treatment". Technology and Culture. **29** (2). Johns Hopkins University Press: 189–218.*
79. **^** *"Epidemics, demonstration effects, and municipal investment in sanitation capital" (PDF). Archived from the original (PDF) on 4 September 2006.*
80. **^** *"Urban waste water treatment in Europe — European Environment Agency". www.eea.europa.eu. Retrieved 29 August 2022.*
81. **^** *"Making Europe's sewage treatment plants more efficient and circular can help meet zero-pollution targets — European Environment Agency". www.eea.europa.eu. Retrieved 29 August 2022.*
82. **^** *"Waste, water and circular economy". Climate Partnerships 2030. 7 September 2021. Retrieved 29 August 2022.*
83. **^** *"Government says polluters can dump risky sewage into rivers as Brexit disrupts water treatment". The Independent. 7 September 2021.*
84. **^** *"Why sewage is causing a political stink". The Week. 26 October 2021.*
85. **^** *"Council Directive 91/271/EEC of 21 May 1991 concerning urban waste-water treatment (91/271/EEC)". Retrieved 19 July 2009.*
86. **^** *"Urban Waste Water Directive Overview". European Commission. Retrieved 19 July 2009.*
87. **^** *Schellenberg, Tatjana; Subramanian, Vrishali; Ganeshan, Ganapathy; Tompkins, David; Pradeep, Rohini (2020). "Wastewater Discharge Standards in the Evolving Context of Urban Sustainability–The Case of India". Frontiers in Environmental Science. **8**. doi:10.3389/fenvs.2020.00030. ISSN 2296-665X. S2CID 215790363.*
88. **^** *Kaur, R; Wani, SP; Singh, AK. "Wastewater production, treatment and use in India" (PDF). AIS. Retrieved 17 November 2020.*
89. **^** Motoyuki Mizuochi: Small-Scale Domestic Wastewater Treatment Technology in Japan, and the Possibility of Technological Transfer, Asian Environment Research Group, National Institute for Environmental Studies, Japan, retrieved on January 6, 2011
90. **^** *"Japan Education Center of Environmental Sanitation". www.jeces.or.jp. Retrieved 23 April 2021.*
91. ^ ***a b*** *"Wastewater Treatment Plants in Libya: Challenges and Future Prospects". International Journal of Environmental Planning and Management.*
92. **^** United States. Federal Water Pollution Control Act Amendments of 1972. Pub. L. 92–500 Approved October 18, 1972. Amended by the Clean Water Act of 1977, Pub. L. 95–217, December 27, 1977; and the Water Quality Act of 1987, Pub. L. 100–4, February 4, 1987.
93. **^** *"National Pollutant Discharge Elimination System". EPA. 21 February 2020.*

94. **^** EPA. "Secondary Treatment Regulation." *Code of Federal Regulations,* 40 CFR Part 133.
95. **^** *"Industrial Effluent Guidelines". EPA. 12 February 2020.*

External links

[edit]

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Wikimedia Commons has media related to ***Sewage treatment***.

- Water Environment Federation – Professional association focusing on municipal wastewater treatment

- v
- t
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Wastewater

Sources and types	○ Acid mine drainage ○ Ballast water ○ Bathroom ○ Blackwater (coal) ○ Blackwater (waste) ○ Boiler blowdown ○ Brine ○ Combined sewer ○ Cooling tower ○ Cooling water ○ Fecal sludge ○ Greywater ○ Infiltration/Inflow ○ Industrial wastewater ○ Ion exchange ○ Leachate ○ Manure ○ Papermaking ○ Produced water ○ Return flow ○ Reverse osmosis ○ Sanitary sewer ○ Septage ○ Sewage ○ Sewage sludge ○ Toilet ○ Urban runoff
Quality indicators	○ Adsorbable organic halides ○ Biochemical oxygen demand ○ Chemical oxygen demand ○ Coliform index ○ Oxygen saturation ○ Heavy metals ○ pH ○ Salinity ○ Temperature ○ Total dissolved solids ○ Total suspended solids ○ Turbidity ○ Wastewater surveillance

Treatment options	○ Activated sludge ○ Aerated lagoon ○ Agricultural wastewater treatment ○ API oil–water separator ○ Carbon filtering ○ Chlorination ○ Clarifier ○ Constructed wetland ○ Decentralized wastewater system ○ Extended aeration ○ Facultative lagoon ○ Fecal sludge management ○ Filtration ○ Imhoff tank ○ Industrial wastewater treatment ○ Ion exchange ○ Membrane bioreactor ○ Reverse osmosis ○ Rotating biological contactor ○ Secondary treatment ○ Sedimentation ○ Septic tank ○ Settling basin ○ Sewage sludge treatment ○ Sewage treatment ○ Sewer mining ○ Stabilization pond ○ Trickling filter ○ Ultraviolet germicidal irradiation ○ UASB ○ Vermifilter ○ Wastewater treatment plant

Disposal options

- Combined sewer
- Evaporation pond
- Groundwater recharge
- Infiltration basin
- Injection well
- Irrigation
- Marine dumping
- Marine outfall
- Reclaimed water
- Sanitary sewer
- Septic drain field
- Sewage farm
- Storm drain
- Surface runoff
- Vacuum sewer

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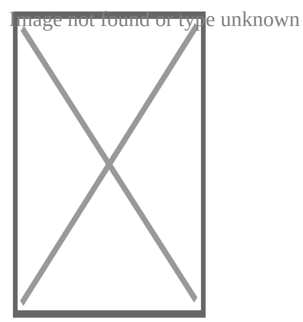
Environmental technology

General

- Appropriate technology
- Clean technology
- Climate smart agriculture
- Environmental design
- Environmental impact assessment
- Eco-innovation
- Ecotechnology
- Electric vehicle
- Energy recycling
- Environmental design
- Environmental impact assessment
- Environmental impact design
- Green building
- Green vehicle
- Environmentally healthy community design
- Public interest design
- Sustainability
- Sustainability science
- Sustainable (agriculture
- architecture
- design
- development
- food systems
- industries
- procurement
- refurbishment
- technology
- transport)



Pollution

- Air pollution (control
- dispersion modeling)
- Industrial ecology
- Solid waste treatment
- Waste management
- Water (agricultural wastewater treatment
- industrial wastewater treatment
- sewage treatment
- waste-water treatment technologies
- water purification)

Sustainable energy

- Efficient energy use
- Electrification
- Energy development
- Energy recovery
- Fuel (alternative fuel
- biofuel
- carbon-neutral fuel
- hydrogen technologies)
- List of energy storage projects
- Renewable energy
    - commercialization
    - transition
- Sustainable lighting
- Transportation (electric vehicle
- hybrid vehicle)
- Building (green
- insulation
- natural
- sustainable architecture
- New Urbanism
- New Classical)

Conservation

- Conservation biology
- Ecoforestry
- Efficient energy use
- Energy conservation
- Energy recovery
- Energy recycling
- Environmental movement
- Environmental remediation
- Glass in green buildings
- Green computing
- Heat recovery ventilation
- High-performance buildings
- Land rehabilitation
- Nature conservation
- Permaculture
- Recycling
- Water heat recycling

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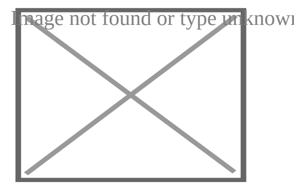
Biosolids, waste, and waste management

Major types

- Agricultural wastewater
- Biodegradable waste
- Biomedical waste
- Brown waste
- Chemical waste
- Construction waste
- Demolition waste
- Electronic waste
    - by country
- Food waste
- Green waste
- Hazardous waste
- Heat waste
- Industrial waste
- Industrial wastewater
- Litter
- Marine debris
- Mining waste
- Municipal solid waste
- Open defecation
- Packaging waste
- Post-consumer waste
- Radioactive waste
- Scrap metal
- Sewage
- Sharps waste
- Surface runoff
- Toxic waste



Processes

- Anaerobic digestion
- Balefill
- Biodegradation
- Composting
- Durable good
- Ecological design
- Garden waste dumping
- Illegal dumping
- Incineration
- Landfill
- Landfill mining
- Mechanical biological treatment
- Mechanical sorting
- Photodegradation
- Reclaimed lumber
- Recycling
  - appliance recycling
  - battery recycling
  - bottle recycling
  - fluorescent lamp recycling
  - land recycling
  - plastic recycling
  - textile recycling
  - timber recycling
  - tire recycling
  - water heat recycling
  - water recycling shower
- Repurposing
- Resource recovery
- Reusable packaging
- Right to repair
- Sewage treatment
- Urban mining
- Waste collection
- Waste sorting
- Waste trade
- Waste treatment
- Waste-to-energy

Countries	◦ Afghanistan ◦ Albania ◦ Armenia ◦ Australia ◦ Belgium ◦ Bangladesh ◦ Brazil ◦ Bosnia and Herzegovina ◦ Egypt ◦ Georgia ◦ Hong Kong ◦ India ◦ Israel ◦ Japan ◦ Kazakhstan ◦ New Zealand ◦ Russia ◦ South Korea ◦ Sri Lanka ◦ Switzerland ◦ Syria ◦ Tanzania ◦ Taiwan ◦ Thailand ◦ Turkey ◦ United Kingdom ◦ United States

Agreements	◦ Bamako Convention
	◦ Basel Convention
	◦ EU directives
	    ◦ batteries
	        ◦ Recycling
	    ◦ framework
	    ◦ incineration
	    ◦ landfills
	    ◦ RoHS
	    ◦ vehicles
	    ◦ waste water
	    ◦ WEEE
	◦ London Convention
	◦ Oslo Convention
	◦ OSPAR Convention

Occupations

- Sanitation worker
- Street sweeper
- Waste collector
- Waste picker

Other topics

- Blue Ribbon Commission on America's Nuclear Future
- China's waste import ban
- Cleaner production
- Downcycling
- Eco-industrial park
- Extended producer responsibility
- High-level radioactive waste management
- History of waste management
- Landfill fire
- Sewage regulation and administration
- Supervised injection site
- Toxic colonialism
- Upcycling
- Waste hierarchy
- Waste legislation
- Waste minimisation
- Zero waste

- Image not found or type unknown icon Environment portal
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National

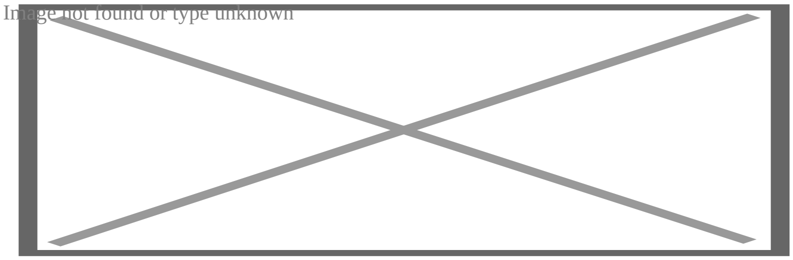
- Germany
- United States
- Japan
- Latvia
- Israel

Other

- Yale LUX

About Sanitation

Not to be confused with Sanitization.



The sanitation system: collection, transport, treatment, disposal or reuse.

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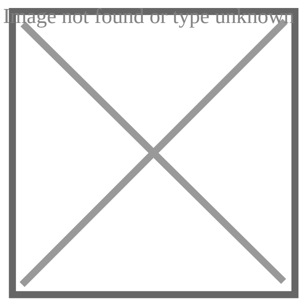
Part of a series on

Public health



- Outline

Subfields

- Community health
- Dental public health
- Environmental health
- Epidemiology
- Health economics
- Health education
- Health promotion
- Health policy
- Health politics
- Mental health
- Occupational safety
- Rehabilitation (penology)
- Sexual and reproductive health
- Sanitation
- World health (Global health - International health)

Prevention

- Disease surveillance
- Harm reduction
- Health promotion (Behavior change)
- Health indicators
- Human right to water and sanitation
- Right to health
- Supervised injection site
- Universal health care

Lists and categories

- Terminology
- Journals
- National public health agencies

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- image not found or type unknown iconSociety portal

Sanitation refers to public health conditions related to clean drinking water and treatment and disposal of human excreta and sewage.[1] Preventing human contact with feces is part of sanitation, as is hand washing with soap. Sanitation systems aim to protect human health by providing a clean environment that will stop the transmission of disease, especially through the fecal–oral route.[2] For example, diarrhea, a main cause of malnutrition and stunted growth in children, can be reduced through adequate sanitation.[3] There are many other diseases which are easily transmitted in communities that have low levels of sanitation, such as ascariasis (a type of intestinal worm infection or helminthiasis), cholera, hepatitis, polio, schistosomiasis, and trachoma, to name just a few.

A range of sanitation technologies and approaches exists. Some examples are community-led total sanitation, container-based sanitation, ecological sanitation, emergency sanitation, environmental sanitation, onsite sanitation and sustainable sanitation. A sanitation system includes the capture, storage, transport, treatment and disposal or reuse of human excreta and wastewater.[4] Reuse activities within the sanitation system may focus on the nutrients, water, energy or organic matter contained in excreta and wastewater. This is referred to as the "sanitation value chain" or "sanitation economy".[5][6] The people responsible for cleaning, maintaining, operating, or emptying a sanitation technology at any step of the sanitation chain are called "sanitation workers".[7]:â€Š2â€Š

Several sanitation "levels" are being used to compare sanitation service levels within countries or across countries.[8] The sanitation ladder defined by the Joint Monitoring Programme in 2016 starts at open defecation and moves upwards using the terms "unimproved", "limited", "basic", with the highest level being "safely managed".[8] This is particularly applicable to developing countries.

The Human right to water and sanitation was recognized by the United Nations General Assembly in 2010. Sanitation is a global development priority and the subject of Sustainable Development Goal 6.[9] The estimate in 2017 by JMP states that 4.5 billion people currently do not have safely managed sanitation.[9] Lack of access to sanitation has an impact not only on public health but also on human dignity and personal safety.

Definitions

[edit]

Animated video to underline the importance of sanitation (here with a focus on toilets) on public health in developing countries

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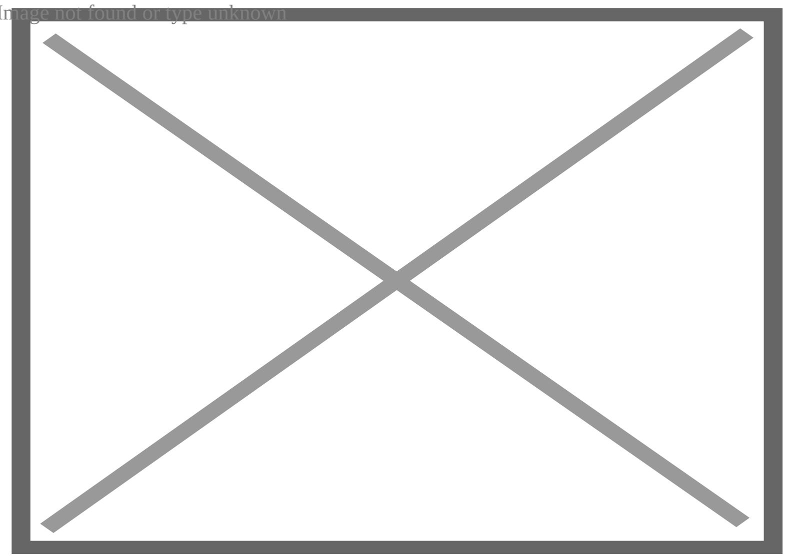


Urban improved sanitation facilities versus rural improved sanitation facilities, 2015.[10]

There are some variations on the use of the term "sanitation" between countries and organizations. The World Health Organization defines the term "sanitation" as follows:

> "Sanitation generally refers to the provision of facilities and services for the safe disposal of human urine and faeces. The word 'sanitation' also refers to the maintenance of hygienic conditions, through services such as garbage collection and wastewater disposal."[11]

Sanitation includes all four of these technical and non-technical systems: Excreta management systems, wastewater management systems (included here are wastewater treatment plants), solid waste management systems as well as drainage systems for rainwater, also called stormwater drainage.[*citation needed*] However, many in the WASH sector only include excreta management in their definition of sanitation.

Another example of what is included in sanitation is found in the handbook by Sphere on "Humanitarian Charter and Minimum Standards in Humanitarian Response" which describes minimum standards in four "key response sectors" in humanitarian response situations. One of them is "Water Supply, Sanitation and Hygiene Promotion" (WASH) and it includes the following areas: Hygiene promotion, water supply, excreta management, vector control, solid waste management and WASH in disease outbreaks and healthcare settings.[12]:â€Š91â€Š

Hygiene promotion is seen by many as an integral part of sanitation. The Water Supply and Sanitation Collaborative Council defines sanitation as "The collection, transport, treatment and disposal or reuse of human excreta, domestic wastewater and solid waste, and associated hygiene promotion."[13]

Despite the fact that sanitation includes wastewater treatment, the two terms are often used side by side as "sanitation and wastewater management".

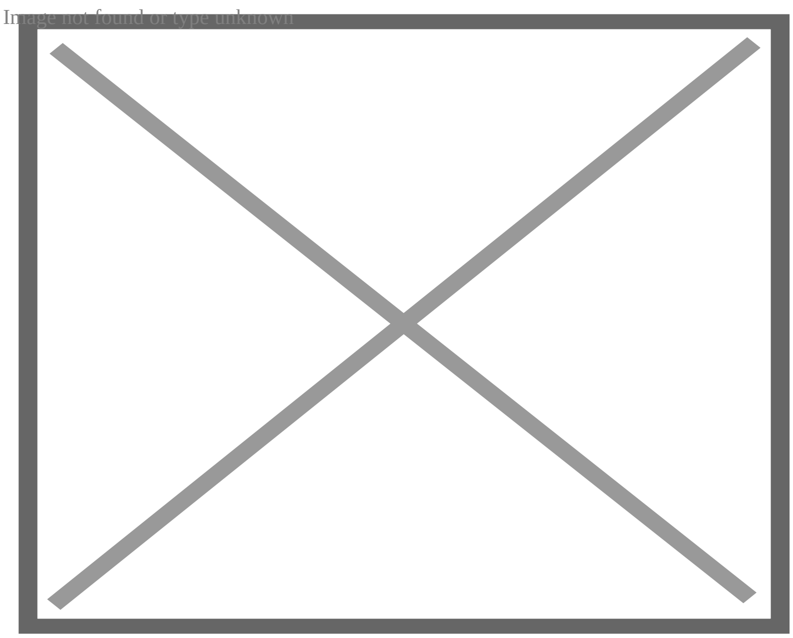
Another definition is in the DFID guidance manual on water supply and sanitation programmes from 1998:[14]

> "For the purposes of this manual, the word 'sanitation' alone is taken to mean the safe management of human excreta. It therefore includes both the 'hardware' (e.g. latrines and sewers) and the 'software' (regulation, hygiene promotion) needed to reduce faecal-oral disease transmission. It encompasses too the re-use and ultimate disposal of human excreta. The term environmental sanitation is used to cover the wider concept of controlling all the factors in the physical environment which may have deleterious impacts on human health and well-being. In developing countries, it normally includes drainage, solid waste management, and vector control, in addition to the activities covered by the definition of sanitation."

Sanitation can include personal sanitation and public hygiene. Personal sanitation work can include handling menstrual waste, cleaning household toilets, and managing household garbage. Public sanitation work can involve garbage collection, transfer and treatment (municipal solid waste management), cleaning drains, streets, schools, trains, public spaces, community toilets and public toilets, sewers, operating sewage treatment plants, etc.[15]:â€Š4â€Š Workers who provide these services for other people are called sanitation workers.

Purposes

[edit]



Access to safe drinking water and sanitation (2016)

The overall purposes of sanitation are to provide a healthy living environment for everyone, to protect the natural resources (such as surface water, groundwater, soil), and to provide safety, security and dignity for people when they defecate or urinate.[*citation ne*

The Human Right to Water and Sanitation was recognized by the United Nations (UN) General Assembly in 2010.[16][17][18] It has been recognized in international law through human rights treaties, declarations and other standards. It is derived from the human right to an adequate standard of living.[19]

Effective sanitation systems provide barriers between excreta and humans in such a way as to break the disease transmission cycle (for example in the case of fecal-borne diseases).[20] This aspect is visualised with the F-diagram where all major routes of fecal-oral disease transmission begin with the letter F: feces, fingers, flies, fields, fluids, food.[21]

Sanitation infrastructure has to be adapted to several specific contexts including consumers' expectations and local resources available.[*citation needed*]

Sanitation technologies may involve centralized civil engineering structures like sewer systems, sewage treatment, surface runoff treatment and solid waste landfills. These structures are designed to treat wastewater and municipal solid waste. Sanitation technologies may also take the form of relatively simple onsite sanitation systems. This can in some cases consist of a simple pit latrine or other type of non-flush toilet for the excreta management part.

Providing sanitation to people requires attention to the entire system, not just focusing on technical aspects such as the toilet, fecal sludge management or the wastewater treatment plant.[22] The "sanitation chain" involves the experience of the user, excreta and wastewater collection methods, transporting and treatment of waste, and reuse or disposal. All need to be thoroughly considered.[22]

Economic impacts

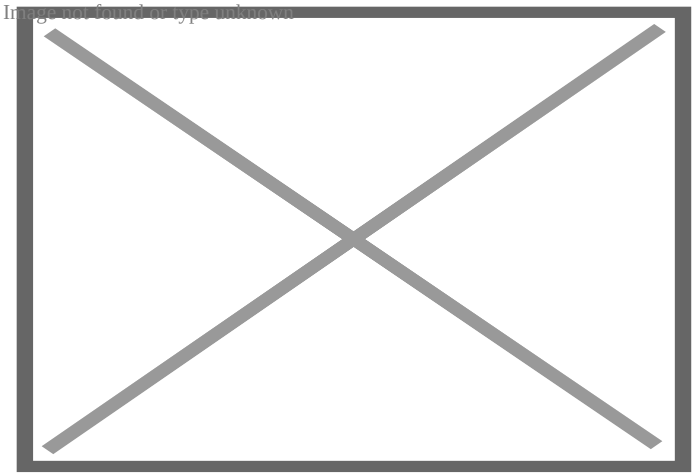
[edit]

The benefits to society of managing human excreta are considerable, for public health as well as for the environment. As a rough estimate: For every US$1 spent on sanitation, the return to society is US$5.50.[23]:â€Š2â€Š

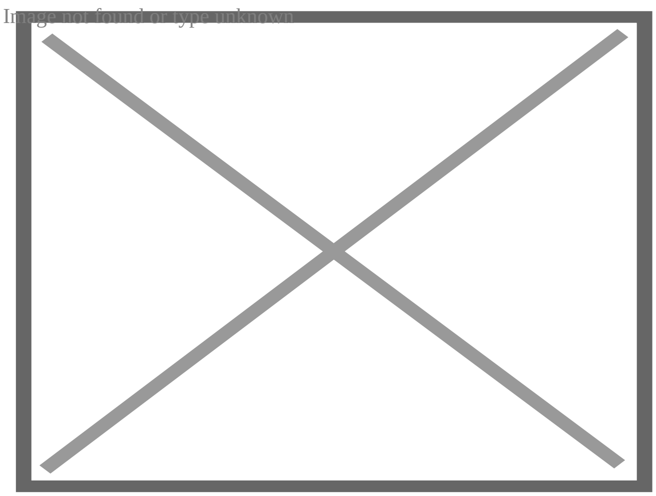
For developing countries, the economic costs of inadequate sanitation is a huge concern. For example, according to a World Bank study, economic losses due to inadequate sanitation to The Indian economy are equivalent to 6.4% of its GDP.[24] Most of these are due to premature mortality, time lost in accessing, loss of productivity, additional costs for healthcare among others.[24] Inadequate sanitation also leads to loss from potential tourism revenue.[24] This study also found that impacts are disproportionately higher for the poor, women and children. Availability of toilet at home on the other hand, positively contributes to economic well-being of women as it leads to an increase in literacy and participation in labor force.[25]

Types and concepts (for excreta management)

[edit]



Percentage of population served by different types of sanitation systems [26]



Example of sanitation infrastructure: Shower, double-vault urine-diverting dry toilet (UDDT) and waterless urinal in Lima, Peru

The term sanitation is connected with various descriptors or adjectives to signify certain types of sanitation systems (which may deal only with human excreta management or with the entire sanitation system, i.e. also greywater, stormwater and solid waste management) – in alphabetical order:

Basic sanitation

[edit]

In 2017, JMP defined a new term: "basic sanitation service". This is defined as the use of improved sanitation facilities that are not shared with other households. A lower level of service is now called "limited sanitation service" which refers to use of improved sanitation facilities that are shared between two or more households. [9]

Container-based sanitation

[edit]
This section is an excerpt from Container-based sanitation. [edit]
Container-based sanitation (abbreviated as CBS) refers to a sanitation system where toilets collect human excreta in sealable, removable containers (also called cartridges) that are transported to treatment facilities.[27] This type of sanitation involves a commercial service which provides certain types of portable toilets, and delivers empty containers when picking up full ones. The service transports and safely disposes of or reuses collected excreta. The cost of collection of excreta is usually borne by the users. With suitable development, support and functioning partnerships, CBS can be used to provide low-income urban populations with safe collection, transport and treatment of excrement at a lower cost than installing and maintaining sewers.[28] In most cases, CBS is based on the use of urine-diverting dry toilets.

Community-based sanitation

[edit]

Community-based sanitation is related to decentralized wastewater treatment (DEWATS).[*citation needed*]

Community-led total sanitation

[edit]

This section is an excerpt from Community-led total sanitation. [edit]

Dry sanitation

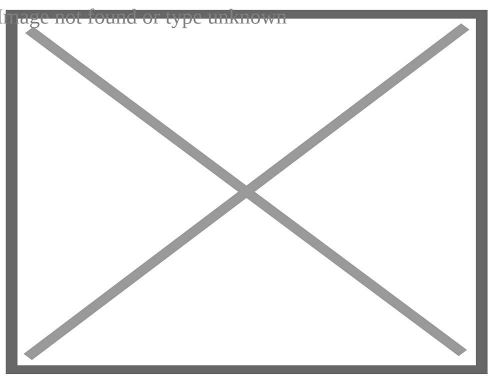
[edit]

The term "dry sanitation" is not in widespread use and is not very well defined. It usually refers to a system that uses a type of dry toilet and no sewers to transport excreta. Often when people speak of "dry sanitation" they mean a sanitation system that uses urine-diverting dry toilet (UDDTs).[29][30]

Ecological sanitation

[edit]

This section is an excerpt from Ecological sanitation. [edit]
Ecological sanitation, commonly abbreviated as ecosan (also spelled eco-san or EcoSan), is an approach to sanitation provision which aims to safely reuse excreta in agriculture.[31] It is an approach, rather than a technology or a device which is characterized by a desire to "close the loop", mainly for the nutrients and organic matter between sanitation and agriculture in a safe manner. One of the aims is to minimise the use of non-renewable resources. When properly designed and operated, ecosan systems provide a hygienically safe system to convert human excreta into nutrients to be returned to the soil, and water to be returned to the land. Ecosan is also called resource-oriented sanitation.



Emergency pit lining kits by Evenproducts

Emergency sanitation

[edit]

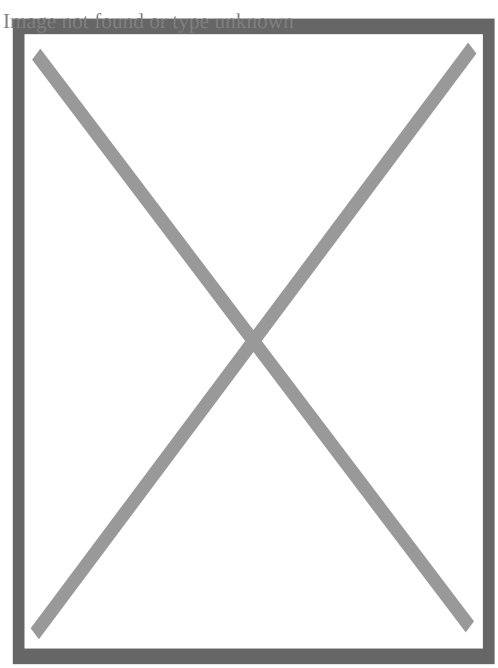
This section is an excerpt from Emergency sanitation. [edit]
Emergency sanitation is the management and technical processes required to provide sanitation in emergency situations. Emergency sanitation is required during humanitarian relief operations for refugees, people affected by natural disasters and internally displaced persons.[32] There are three phases of emergency response: Immediate, short term and long term.[32] In the immediate phase, the focus is on

managing open defecation, and toilet technologies might include very basic latrines, pit latrines, bucket toilets, container-based toilets, chemical toilets. The short term phase might also involve technologies such as urine-diverting dry toilets, septic tanks, decentralized wastewater systems. Providing handwashing facilities and management of fecal sludge are also part of emergency sanitation.

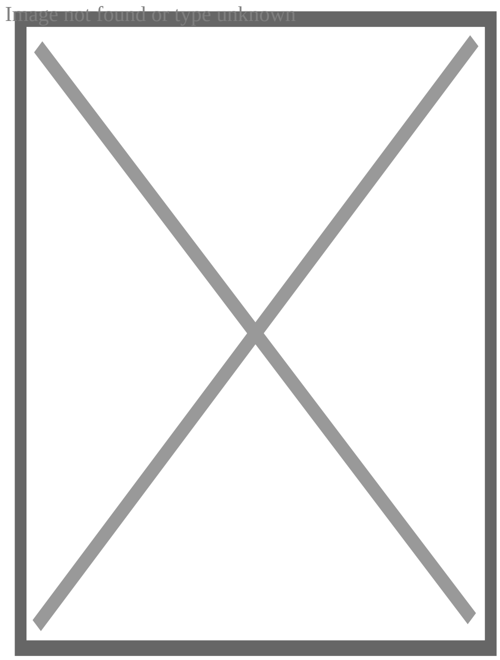
Environmental sanitation

[edit]

Environmental sanitation encompasses the control of environmental factors that are connected to disease transmission. Subsets of this category are solid waste management, water and wastewater treatment, industrial waste treatment and noise pollution control. According to World health organization (WHO) Environmental sanitation was defined as the control of all those factors in the physical environment which exercise a harmful effect on human being physical development, health and survival. One of the primary function of environmental sanitation is to protect public health.[*citation needed*]



Environmental sanitation by an NGO member



A clean exercise organized by an NGO

Fecal sludge management

[edit]

This section is an excerpt from Fecal sludge management. [edit]
Fecal sludge management (FSM) (or faecal sludge management in British English) is the storage, collection, transport, treatment and safe end use or disposal of fecal sludge.[33] Together, the collection, transport, treatment and end use of fecal sludge constitute the "value chain" or "service chain" of fecal sludge management. Fecal sludge is defined very broadly as what accumulates in onsite sanitation systems (e.g. pit latrines, septic tanks and container-based solutions) and specifically is not transported through a sewer. It is composed of human excreta, but also anything else that may go into an onsite containment technology, such as flushwater, cleansing materials (e.g. toilet paper and anal cleansing materials), menstrual hygiene products, grey water (i.e. bathing or kitchen water, including fats, oils and grease), and solid waste. Fecal sludge that is removed from septic tanks is called septage.

Improved and unimproved sanitation

[edit]

This section is an excerpt from Improved sanitation. [edit]

Improved sanitation (related to but distinct from a "safely managed sanitation service") is a term used to categorize types of sanitation for monitoring purposes. It refers to the management of human feces at the household level. The term was coined by the Joint Monitoring Program (JMP) for Water Supply and Sanitation of UNICEF and WHO in 2002 to help monitor the progress towards Goal Number 7 of the Millennium Development Goals (MDGs). The opposite of "improved sanitation" has been termed "unimproved sanitation" in the JMP definitions. The same terms are used to monitor progress towards Sustainable Development Goal 6 (Target 6.2, Indicator 6.2.1) from 2015 onwards.[34] Here, they are a component of the definition for "safely managed sanitation service".

Lack of sanitation

[edit]

Lack of sanitation refers to the absence of sanitation. In practical terms it usually means lack of toilets or lack of hygienic toilets that anybody would want to use voluntarily. The result of lack of sanitation is usually open defecation (and open urination but this is of less concern) with associated serious public health issues.[35] It is estimated that 2.4 billion people still lacked improved sanitation facilities including 660 million people who lack access to safe drinking water as of 2015.[36][37]

Onsite sanitation or non-sewered sanitation system

[edit]

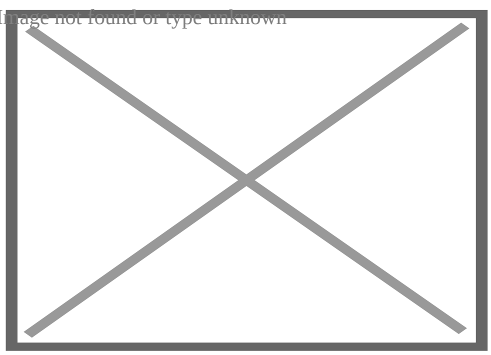
Onsite sanitation (or on-site sanitation) is defined as "a sanitation system in which excreta and wastewater are collected and stored or treated on the plot where they are generated".[22]:â€Š173â€Š Another term that is used for the same system is non-sewered sanitation systems (NSSS), which are prevalent in many countries.[38] NSSS play a vital role in the safe management of fecal sludge, accounting for approximately half of all existing sanitation provisions.[38] The degree of treatment may be variable, from none to advanced. Examples are pit latrines (no treatment) and septic tanks (primary treatment of wastewater). On-site sanitation systems are often connected to fecal sludge management (FSM) systems where the fecal sludge that is generated onsite is treated at an offsite location. Wastewater (sewage) is only generated when piped water supply is available within the buildings or close to them.[*citation needed*]

A related term is a decentralized wastewater system which refers in particular to the wastewater part of on-site sanitation. Similarly, an onsite sewage facility can treat the wastewater generated locally.[*citation needed*]

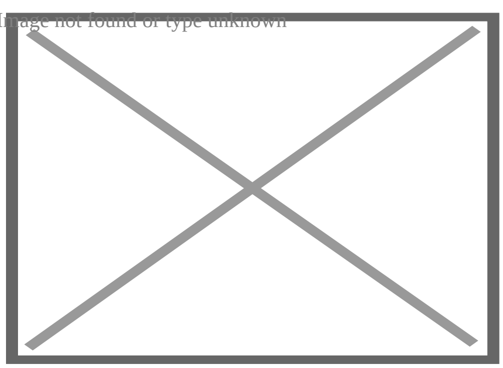
The global methane emissions from NSSS in 2020 was estimated to as 377 Mt CO2e per year or 4.7% of global anthropogenic methane emissions, which are comparable to the greenhouse gas emissions from wastewater treatment plants.[38] This means that the GHG emissions from the NSSS as a non-negligible source.[38]

Safely managed sanitation

[edit]



Share of population using safely managed sanitation facilities in 2022[39]



Number of handwashing facilities in the world, 2022

Safely managed sanitation is the highest level of household sanitation envisioned by the Sustainable Development Goal Number 6.[40] It is measured under the Sustainable Development Goal 6.2, Indicator 6.2.1, as the "Proportion of population using (a) safely managed sanitation services and (b) a hand-washing facility with soap and water".[41][9] The current value in the 2017 baseline estimate by JMP is that 4.5 billion people currently do not have safely managed sanitation.[9]

Safely managed sanitation is defined as an improved sanitation facility which is not shared with other households, and where the excreta produced is either treated and disposed in situ, stored temporarily and then emptied and transported to treatment off-site, or transported through a sewer with wastewater and then treated off-site. [41] In other words, safely managed sanitation is a basic sanitation service where in addition excreta are safely disposed of in situ or transported and treated offsite. [9]

Sustainable sanitation

[edit]

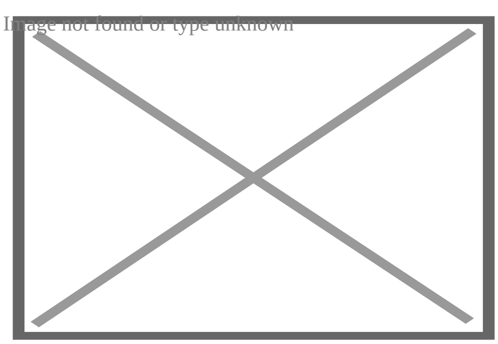
This section is an excerpt from Sustainable sanitation. [edit]
Sustainable sanitation is a sanitation system designed to meet certain criteria and to work well over the long-term. Sustainable sanitation systems consider the entire "sanitation value chain", from the experience of the user, excreta and wastewater collection methods, transportation or conveyance of waste, treatment, and reuse or disposal.[42] The Sustainable Sanitation Alliance (SuSanA) includes five features (or criteria) in its definition of "sustainable sanitation": Systems need to be economically and socially acceptable, technically and institutionally appropriate and protect the environment and natural resources.[43]

Other types, concepts and systems

[edit]

Wastewater management

[edit]
Main articles: Wastewater and Wastewater treatment



Sewage treatment plant, Australia.

Wastewater management consists of collection, wastewater treatment (be it municipal or industrial wastewater), disposal or reuse of treated wastewater. The latter is also referred to as water reclamation.[*citation needed*]

Sanitation systems in urban areas of developed countries usually consist of the collection of wastewater in gravity driven sewers, its treatment in wastewater treatment plants for reuse or disposal in rivers, lakes or the sea.[*citation needed*]

In developing countries most wastewater is still discharged untreated into the environment. Alternatives to centralized sewer systems include onsite sanitation, decentralized wastewater systems, dry toilets connected to fecal sludge management.

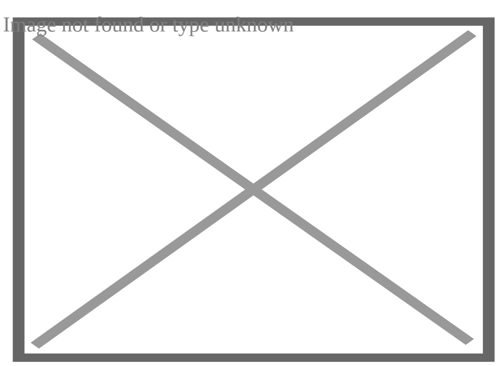
Stormwater drainage

[edit]
Main article: Storm drain

Sewers are either combined with storm drains or separated from them as sanitary sewers. Combined sewers are usually found in the central, older parts or urban areas. Heavy rainfall and inadequate maintenance can lead to combined sewer overflows or sanitary sewer overflows, i.e., more or less diluted raw sewage being discharged into the environment. Industries often discharge wastewater into municipal sewers, which can complicate wastewater treatment unless industries pre-treat their discharges.[44]

Solid waste disposal

[edit]
Main article: Waste management



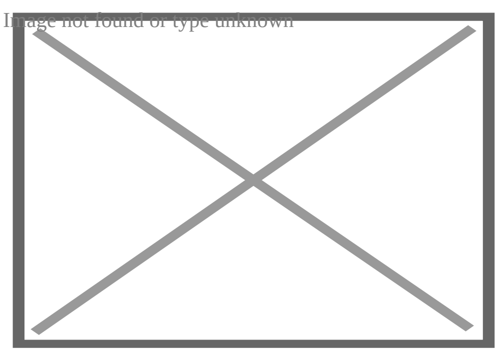
Hiriya Landfill, Israel.

Disposal of solid waste is most commonly conducted in landfills, but incineration, recycling, composting and conversion to biofuels are also avenues. In the case of landfills, advanced countries typically have rigid protocols for daily cover with topsoil, where underdeveloped countries customarily rely upon less stringent protocols.[45] The importance of daily cover lies in the reduction of vector contact and spreading of pathogens. Daily cover also minimizes odor emissions and reduces windblown litter. Likewise, developed countries typically have requirements for perimeter sealing of the landfill with clay-type soils to minimize migration of leachate that could contaminate groundwater (and hence jeopardize some drinking water supplies).

For incineration options, the release of air pollutants, including certain toxic components is an attendant adverse outcome. Recycling and biofuel conversion are the sustainable options that generally have superior lifecycle costs, particularly when total ecological consequences are considered.[46] Composting value will ultimately be limited by the market demand for compost product.[*citation needed*]

Food safety

[edit]



Modern restaurant food preparation area.

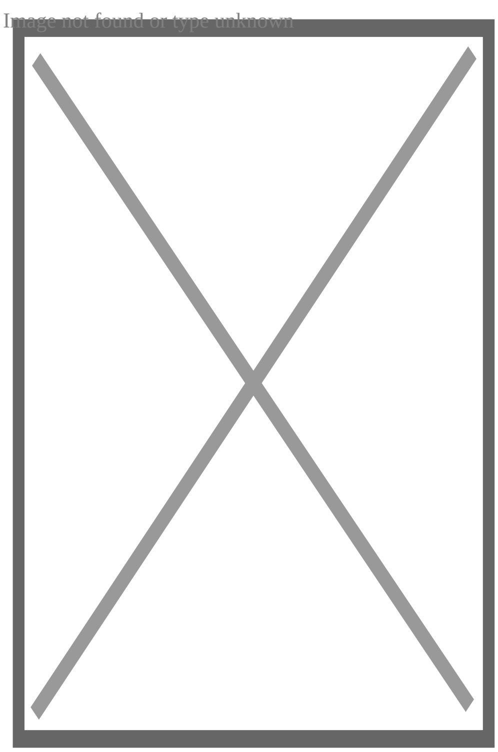
Main article: Food safety

Sanitation within the food industry means the adequate treatment of food-contact surfaces by a process that is effective in destroying vegetative cells of microorganisms of public health significance, and in substantially reducing numbers of other undesirable microorganisms, but without adversely affecting the food or its safety for the consumer (U.S. Food and Drug Administration, Code of Federal Regulations, 21CFR110, USA). Sanitation Standard Operating Procedures are mandatory for food industries in United States. Similarly, in Japan, food hygiene has to be achieved through compliance with food sanitation law.[47]

In the food and biopharmaceutical industries, the term "sanitary equipment" means equipment that is fully cleanable using clean-in-place (CIP) and sterilization-in-place (SIP) procedures: that is fully drainable from cleaning solutions and other liquids. The design should have a minimum amount of deadleg, or areas where the turbulence during cleaning is insufficient to remove product deposits.[48] In general, to improve cleanability, this equipment is made from Stainless Steel 316L, (an alloy containing small amounts of molybdenum). The surface is usually electropolished to an effective surface roughness of less than 0.5 micrometre to reduce the possibility of bacterial adhesion.

Hygiene promotion

[edit]
Further information: Hygiene



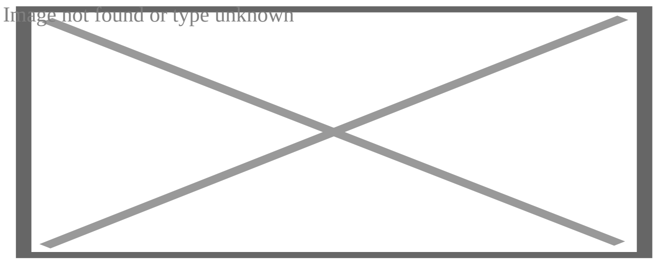
Hygiene education (on proper handwashing) in Afghanistan

In many settings, provision of sanitation facilities alone does not guarantee good health of the population. Studies have suggested that the impact of hygiene practices have as great an impact on sanitation related diseases as the actual provision of sanitation facilities. Hygiene promotion is therefore an important part of sanitation and is usually key in maintaining good health.[49]

Hygiene promotion is a planned approach of enabling people to act and change their behavior in an order to reduce and/or prevent incidences of water, sanitation and hygiene (WASH)[50] related diseases. It usually involves a participatory approach of engaging people to take responsibility of WASH services and infrastructure including its operation and maintenance. The three key elements of promoting hygiene are; mutual sharing of information and knowledge, the mobilization of affected communities and the provision of essential material and facilities.[12]

Health aspects

[edit]



The "F-diagram" (feces, fingers, flies, fields, fluids, food), showing pathways of fecal-oral disease transmission. The vertical blue lines show barriers: toilets, safe water, hygiene and handwashing.

A video shedding light on the unsafe and undignified working conditions of many sanitation workers in India

Main article: WASH § Health aspects

This section is an excerpt from WASH § WASH-attributable burden of diseases and injuries.[edit]

The WHO has investigated which proportion of death and disease worldwide can be attributed to insufficient WASH services. In their analysis they focus on the following four health outcomes: diarrhea, acute respiratory infections, malnutrition, and soil-transmitted Helminthiasis (STHs).[51]:â€Šviâ€Š These health outcomes are also included as an indicator for achieving Sustainable Development Goal 3 ("Good Health and Well-being"): Indicator 3.9.2 reports on the "mortality rate attributed to unsafe water, sanitation, and lack of hygiene".

In 2023, WHO summarized the available data with the following key findings: "In 2019, use of safe WASH services could have prevented the loss of at least 1.4 million lives and 74 million disability-adjusted life years (DALYs) from four health outcomes. This represents 2.5% of all deaths and 2.9% of all DALYs globally."[51]:â€Šviâ€Š Of the four health outcomes studied, it was diarrheal disease that had the most striking correlation, namely the highest number of "attributable burden of disease": over 1 million deaths and 55 million DALYs from diarrheal diseases were linked with lack of WASH. Of these deaths, 564,000 deaths were linked to unsafe sanitation in particular.

Environmental aspects

[edit]

Indicator organisms

[edit]

When analyzing environmental samples, various types of indicator organisms are used to check for fecal pollution of the sample. Commonly used indicators for bacteriological water analysis include the bacterium *Escherichia coli* (abbreviated as *E. coli)* and non-specific fecal coliforms. With regards to samples of soil, sewage sludge, biosolids or fecal matter from dry toilets, helminth eggs are a commonly used indicator. With helminth egg analysis, eggs are extracted from the sample after which a viability test is done to distinguish between viable and non viable eggs. The viable fraction of the helminth eggs in the sample is then counted.

Climate change

[edit]
Main article: WASH § Climate change aspects

Global mechanisms

[edit]

Sustainable Development Goal Number 6

[edit]
Further information: Sustainable Development Goal 6

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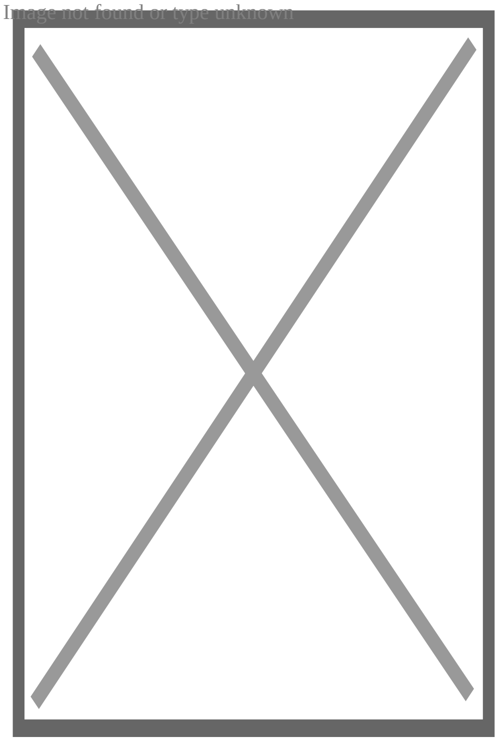
United Nations SDG 6 Logo

In the year 2016, the Sustainable Development Goals replaced the Millennium Development Goals. Sanitation is a global development priority and included Sustainable Development Goal 6 (SDG 6).[9] The target is about "clean water and sanitation for all" by 2030.[52] It is estimated that 660 million people still lacked access to safe drinking water as of 2015.[36][37]

Since the COVID-19 pandemic in 2020, the fight for clean water and sanitation is more important than ever. Handwashing is one of the most common prevention methods for Coronavirus, yet two out of five people do not have access to a hand-washing station.[53]

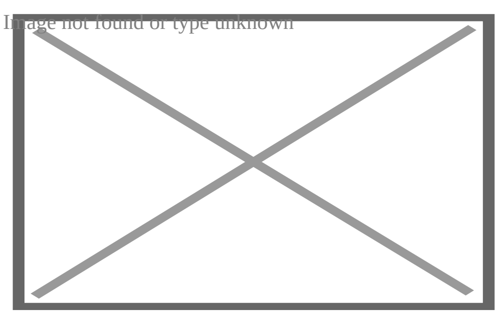
Millennium Development Goal Number 7 until 2015

[edit]



Example for lack of sanitation: Unhygienic pit latrine with ring slab in Kalibari community in Mymensingh, Bangladesh

The United Nations, during the Millennium Summit in New York in 2000 and the 2002 World Summit on Sustainable Development in Johannesburg, developed the Millennium Development Goals (MDGs) aimed at poverty eradication and sustainable development. The specific sanitation goal for the year 2015 was to reduce by half the number of people who had no access to potable water and sanitation in the baseline year of 1990. As the JMP and the United Nations Development Programme (UNDP) Human Development Report in 2006 has shown, progress meeting the MDG sanitation target is slow, with a large gap between the target coverage and the current reality.



Modified logo of International Year of Sanitation, used in the UN Drive to 2015 campaign logo

In December 2006, the United Nations General Assembly declared 2008 "The International Year of Sanitation", in recognition of the slow progress being made towards the MDGs sanitation target.[54] The year aimed to develop awareness and more actions to meet the target.

There are numerous reasons for this gap. A major one is that sanitation is rarely given political attention received by other topics despite its key importance. Sanitation is not high on the international development agenda, and projects such as those relating to water supply projects are emphasised.[55]

The Joint Monitoring Programme for Water Supply and Sanitation of WHO and UNICEF (JMP) has been publishing reports of updated estimates every two years on the use of various types of drinking-water sources and sanitation facilities at the national, regional and global levels. The JMP report for 2015 stated that:[36]

- Between 1990 and 2015, open defecation rates have decreased from 38% to 25% globally. Just under one billion people (946 million) still practise open defecation worldwide in 2015.
- 82% of the global urban population, and 51% of the rural population is using improved sanitation facilities in 2015, as per the JMP definition of "improved sanitation".[56]

Initiatives to promote sanitation

[edit]

In 2011 the Bill & Melinda Gates Foundation launched the "Reinvent the Toilet Challenge" to promote safer, more effective ways to treat human waste.[57] The program is aimed at developing technologies that might help bridge the global sanitation gap (for example the Omni Processor, or technology for fecal sludge management). In 2015, the Bill & Melinda Gates Foundation published their "Water, sanitation, and hygiene strategy portfolio update and overview" called "Building demand for sanitation".[58]

The latest innovations in the field of public health sanitation, currently in the testing phase, comprise - use of 'locally produced alcohol-based hand rub'; 'novel latrine improvement'; and 'container-based sanitation'. Centers for Disease Control and Prevention (CDC), the national public health agency of the United States has recognized the stated three initiatives.

Capacity development

[edit]

Capacity development is regarded as an important mechanism to achieve progress in the sanitation sector.[59] For example, in India the Sanitation Capacity Building platform (SCBP) was designed to "support and build the capacity of town/cities to plan and implement decentralized sanitation solutions" with funding by the Bill & Melinda Gates Foundation from 2015 to 2022.[60][61] Results from this project showed that capacity development best happens on the job and in a learning organization culture.[62] In a government capacity development initiative, it is critical to have an enabling policy and program funding to translate capacity development input into program and infrastructure outputs. Capacity development aims to empower staff and institutions, develop a learning strategy, learning content and training modules, as well as strengthened partnerships and institutions of learning.[62] The Capacity Development Effectiveness Ladder Framework (CDEL) identifies five critical steps for capacity development interventions: Developing original learning content, partnerships for learning and outreach, learning strategy, visioning change and designing solutions, contribution to capacity development discourse.[62][63]

Costs

[edit]

A study was carried out in 2018 to compare the lifecycle costs of full sanitation chain systems in developing cities of Africa and Asia. It found that conventional sewer systems are in most cases the most expensive sanitation options, followed, in order of cost, by sanitation systems comprising septic tanks, ventilated improved pit latrines (VIP), urine diversion dry toilets and pour-flush pit latrines.[64] The main determinants of urban sanitation financial costs include: Type of technology, labour, material and utility cost, density, topography, level of service provided by the sanitation system, soil condition, energy cost and others (distance to wastewater treatment facility, climate, end-use of treatment products, business models, water table height).[64]

Some grassroots organizations have trialled community-managed toilet blocks whose construction and maintenance costs can be covered by households. One study of Mumbai informal settlements found that US$1.58 per adult would be sufficient for construction, and less than US$1/household/month would be sufficient for maintenance.[65]

History

[edit]

Further information: History of water supply and sanitation, Toilet § History, and History of waste management

Major human settlements could initially develop only where fresh surface water was plentiful, such as near rivers or natural springs. Throughout history people have devised systems to get water into their communities and households, and to dispose (and later also treat) wastewater.[66] The focus of sewage treatment at that time was on conveying raw sewage to a natural body of water, e.g. a river or ocean, where it would be diluted and dissipated.

The Sanitation in the Indus Valley Civilization in Asia is an example of public water supply and sanitation during the Bronze Age (3300–1300 BCE). Sanitation in ancient Rome was quite extensive. These systems consisted of stone and wooden drains to collect and remove wastewater from populated areas—see for instance the Cloaca Maxima into the River Tiber in Rome. The first sewers of ancient Rome were built between 800 and 735 BCE.[67]

By country

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Water supply and sanitation by country

- Afghanistan
- Algeria
- Angola
- Argentina
- Australia
- Azerbaijan
- Bangladesh
- Belgium
- Belize
- Benin
- Bhutan
- Bolivia
- Bosnia and Herzegovina
- Brazil
- Burkina Faso
- Cambodia
- Canada
- Chile
- China
- Colombia
- Costa Rica
- Cuba
- Democratic Republic of the Congo
- Denmark
- Dominican Republic
- Ecuador
- Egypt
- El Salvador
- Ethiopia
- France
- Georgia
- Germany
- Ghana
- Greece
- Grenada
- Guatemala
- Guyana
- Haiti
- Honduras
- India
- Indonesia
- Iran
- Iraq
- Ireland
- Israel
- Italy
- Jamaica
- Japan

Society and culture

[edit]

There is a vast number of professions that are involved in the field of sanitation, for example on the technical and operations side: sanitation workers, waste collectors, sanitary engineers.

See also

[edit]

- List of abbreviations used in sanitation
- List of countries by proportion of the population using improved sanitation facilities
- List of water supply and sanitation by country
- Environmental health
- Water pollution
- Water security
- Self-supply of water and sanitation
- Sustainable Sanitation Alliance
- World Toilet Day

References

[edit]

1. **^** *"sanitation | Definition of sanitation in English by Oxford Dictionaries". Oxford Dictionaries | English. Archived from the original on November 17, 2017. Retrieved 2017-11-17.*
2. **^** SuSanA (2008). Towards more sustainable sanitation solutions Archived 2017-10-12 at the Wayback Machine. Sustainable Sanitation Alliance (SuSanA)
3. **^** *"Diarrhoeal disease". World Health Organization. Archived from the original on 2014-04-01. Retrieved 2017-11-17.*
4. **^** *Gates Foundation (2010). "Water Sanitation Hygiene Fact Sheet 2010" (PDF). Gates Foundation. Archived (PDF) from the original on 2020-10-21. Retrieved 2017-11-17.*
5. **^** *Paranipe, Nitin (19 September 2017). "The rise of the sanitation economy: how business can help solve a global crisis". Thomson Reuters Foundation News. Archived from the original on 29 December 2019. Retrieved November 13, 2017.*
6. **^** *Introducing the Sanitation Economy (PDF). Toilet Board Coalition. 2017. Archived (PDF) from the original on 2018-07-31. Retrieved 2017-12-19.*
7. **^** World Bank, ILO, WaterAid, and WHO (2019). Health, Safety and Dignity of Sanitation Workers: An Initial Assessment Archived 2022-12-11 at the Wayback Machine. World Bank, Washington, DC.

8. ^ ***a*** ***b*** *"Sanitation | JMP". washdata.org. Archived from the original on 2021-07-21. Retrieved 2017-11-17.*
9. ^ ***a*** ***b*** ***c*** ***d*** ***e*** ***f*** ***g*** WHO and UNICEF (2017) Progress on Drinking Water, Sanitation and Hygiene: 2017 Update and SDG Baselines Archived 2019-07-25 at the Wayback Machine. Geneva: World Health Organization (WHO) and the United Nations Children's Fund (UNICEF), 2017
10. **^** *"Urban sanitation facilities vs. rural sanitation facilities". Our World in Data. Archived from the original on 19 September 2020. Retrieved 6 March 2020.*
11. **^** *"Sanitation". Health topics. World Health Organization. Archived from the original on 2020-06-06. Retrieved 2020-10-05.*
12. ^ ***a*** ***b*** Sphere Association (2018) The Sphere Handbook: Humanitarian Charter and Minimum Standards in Humanitarian Response Archived 2019-05-12 at the Wayback Machine, fourth edition, Geneva, Switzerland, 2018.
13. **^** Evans, B., van der Voorden, C., Peal, A. (2009). Public Funding for Sanitation - The many faces of sanitation subsidies Archived 2017-10-11 at the Wayback Machine. Water Supply and Sanitation Collaborative Council (WSSCC), Geneva, Switzerland, p. 35
14. **^** WELL (1998) DFID guidance manual on water supply and sanitation programmes Archived 2022-01-20 at the Wayback Machine WELL Loughborough University UK
15. **^** PRIA (2019): Lived Realities of Women Sanitation Workers in India: Insights from a Participatory Research Conducted in Three Cities of India Archived 2022-12-11 at the Wayback Machine. Participatory Research in Asia, New Delhi, India
16. **^** *"General Assembly" (PDF). Archived (PDF) from the original on 2017-03-19. Retrieved 2019-11-25.*
17. **^** Human Rights Council resolution 15/9, *Human rights and access to safe drinking water and sanitation*, (6 October 2010), available from http://www.right2water.eu/sites/water/files/UNHRC%20Resolution%2015-9.pdf Archived 2017-05-17 at the Wayback Machine
18. **^** *"The human rights to safe drinking water and sanitation". Archived from the original (PDF) on 2017-08-25. Retrieved 2019-11-25.*
19. **^** Right to water and sanitation derive from the right to an adequate standard of living. http://www.ohchr.org/EN/NewsEvents/Pages/DisplayNews.aspx?NewsID=10403&LangID Archived 2022-03-06 at the Wayback Machine
20. **^** Thor Axel Stenström (2005) Breaking the sanitation barriers; WHO Guidelines for excreta use as a baseline for environmental health Archived 2008-11-22 at the Wayback Machine, Ecosan Conference, Durban, South Africa
21. **^** *Conant, Jeff (2005). Sanitation and Cleanliness for a Healthy Environment (PDF). Berkeley, California, USA: The Hesperian Foundation in collaboration with the United Nations Development Programme (UNDP), Sida. p. 6. Archived from the original (PDF) on 2014-10-21.*

22. ^ ***a b c*** Tilley, E., Ulrich, L., Lüthi, C., Reymond, Ph. and Zurbrügg, C. (2014). Compendium of Sanitation Systems and Technologies. 2nd Revised Edition Archived 2021-08-28 at the Wayback Machine. Swiss Federal Institute of Aquatic Science and Technology (Eawag), Duebendorf, Switzerland
23. **^** *WWAP (United Nations World Water Assessment Programme) (2017). The United Nations World Water Development Report 2017. Wastewater: The Untapped Resource. Paris. ISBN 978-92-3-100201-4. Archived from the original on 2017-04-08.*cite book: CS1 maint: location missing publisher (link)
24. ^ ***a b c*** *WSP (2011). The economic Impacts of Inadequate Sanitation in India. Water and Sanitation Programme, The World Bank.*
25. **^** *Gius, Mark; Subramanian, Ramesh (2015). "The Relationship between Inadequate Sanitation Facilities and the Economic Well-Being of Women in India". Journal of Economics and Development Studies.* ***3*** *(1). doi: 10.15640/jeds.v3n1a2 (inactive 12 July 2025). ISSN 2334-2382.*cite journal: CS1 maint: DOI inactive as of July 2025 (link)
26. **^** *WWAP (United Nations World Water Assessment Programme) (2017). The United Nations World Water Development Report 2017. Wastewater: The Untapped Resource. Paris. ISBN 978-92-3-100201-4. Archived from the original on 2017-04-08.*cite book: CS1 maint: location missing publisher (link)
27. **^** *Tilmans, Sebastien; Russel, Kory; Sklar, Rachel; Page, Leah; Kramer, Sasha; Davis, Jennifer (2015-04-13). "Container-based sanitation: assessing costs and effectiveness of excreta management in Cap Haitien, Haiti". Environment and Urbanization.* ***27*** *(1): 89–104. Bibcode:2015EnUrb..27...89T. doi:10.1177/0956247815572746. PMC 4461065. PMID 26097288.*
28. **^** *Shepard, J.; Stevens, C.; Mikhael, G. (2017). The world can't wait for sewers; Advancing container-based sanitation businesses as a viable answer to the global sanitation crisis. EY, WSUP.*
29. **^** Platzer, C., Hoffmann, H., Ticona, E. (2008). Alternatives to waterborne sanitation – a comparative study – limits and potentials Archived 2017-10-09 at the Wayback Machine. IRC Symposium: Sanitation for the urban poor – partnerships and governance, Delft, The Netherlands
30. **^** Flores, A. (2010). *Towards sustainable sanitation: evaluating the sustainability of resource-oriented sanitation* Archived 2017-06-29 at the Wayback Machine. PhD Thesis, University of Cambridge, UK
31. **^** *GTZ, IWA (2003). Ecosan - closing the loop - Proceedings of the 2nd international symposium, 7th–11th April 2003, Lübeck, Germany. Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH and International Water Association (IWA).*
32. ^ ***a b*** *Harvey, Peter; et al. (2007). Excreta disposal in emergencies a field manual: an inter-agency publication. Loughborough: Loughborough university. Water, engineering and development centre (WEDC). p. 250. ISBN 978-1-84380-113-9.*

33. **^** *Velkushanova, Konstantina; Strande, Linda; Ronteltap, Mariska; Koottatep, Thammarat; Brdjanovic, Damir; Buckley, Chris, eds. (2021). Methods for Faecal Sludge Analysis. IWA Publishing. doi:10.2166/9781780409122. ISBN 978-1780409122.* Image not found or type unknown Text was copied from this source, which is available under a Creative Commons Attribution 4.0 International License.
34. **^** WHO and UNICEF (2017) Progress on Drinking Water, Sanitation and Hygiene: 2017 Update and SDG Baselines. Geneva: World Health Organization (WHO) and the United Nations Children's Fund (UNICEF), 2017
35. **^** *Mara, Duncan (2017). "The elimination of open defecation and its adverse health effects: a moral imperative for governments and development professionals". Journal of Water Sanitation and Hygiene for Development.* ***7*** *(1): 1–12. Bibcode:2017JWSHD...7....1M. doi:10.2166/washdev.2017.027. ISSN 2043-9083. Archived from the original on 2018-06-21. Retrieved 2017-08-17.*
36. ^ ***a b c*** WHO and UNICEF *Progress on Sanitation and Drinking-water: 2015 Update Archived 2021-02-12 at the Wayback Machine*, WHO, Geneva and UNICEF, New York
37. ^ ***a b*** *European Investment Bank (2019). On Water. Publications Office. doi:10.2867/509830. ISBN 9789286143199. Archived from the original on 2020-11-29. Retrieved 2020-12-07.* cite book: |website= ignored (help)
38. ^ ***a b c d*** *Cheng, Shikun; Long, Jinyun; Evans, Barbara; Zhan, Zhe; Li, Tianxin; Chen, Cong; Mang, Heinz-Peter; Li, Zifu (2022). "Non-negligible greenhouse gas emissions from non-sewered sanitation systems: A meta-analysis". Environmental Research.* ***212*** *(Pt D): 113468. Bibcode:2022ER....21213468C. doi:10.1016/j.envres.2022.113468. PMC 9227720. PMID 35597295.* Image not found or type unknown Text was copied from this source, which is available under a Creative Commons Attribution 4.0 International License Archived 2017-10-16 at the Wayback Machine
39. **^** Ritchie, Roser, Mispy, Ortiz-Ospina (2018) "Measuring progress towards the Sustainable Development Goals." (SDG 6) Archived 2020-11-01 at the Wayback Machine *SDG-Tracker.org, website*
40. **^** *"JMP - Sanitation". washdata.org. Joint Monitoring Programme of UNICEF and WHO. Archived from the original on 21 July 2021. Retrieved 25 February 2021.*
41. ^ ***a b*** *"Indicator 6.2.1 - Proportion of population using safely managed sanitation services, including a handwashing facility with soap and water". sdg6monitoring.org. UN Water. Archived from the original on 3 March 2021. Retrieved 25 February 2021.*
42. **^** Tilley, E., Ulrich, L., Lüthi, C., Reymond, Ph. and Zurbrügg, C. (2014). Compendium of Sanitation Systems and Technologies. 2nd Revised Edition. Swiss Federal Institute of Aquatic Science and Technology (Eawag), Duebendorf, Switzerland
43. **^** SuSanA (2008). Towards more sustainable sanitation solutions - SuSanA Vision Document. Sustainable Sanitation Alliance (SuSanA)

44. **^** *Environmental Biotechnology: Advancement in Water And Wastewater Application*, edited by Z. Ujang, IWA Proceedings, Malaysia (2003)
45. **^** George Tchobanoglous and Frank Kreith *Handbook of Solid Waste Management*, McGraw Hill (2002)
46. **^** William D. Robinson, *The Solid Waste Handbook: A Practical Guide*, John Wiley and sons (1986)
47. **^** *Japan External Trade Organization. "Food Sanitation Law in Japan" (PDF). Archived from the original (PDF) on 9 April 2008. Retrieved 1 March 2008.*
48. **^** Treatment of deadleg plumbing areas
49. **^** *Reed, Brian; Bevan, Jane (2014). Managing hygiene promotion in WASH programmes. Leicestershire, UK: Water, Engineering and Development Centre (WEDC), Loughborough University. ISBN 978-1-84380-168-9.*
50. **^** *"2021 water, sanitation and hygiene barometer" (PDF). SOLIDARITÉS INTERNATIONAL. 2021. Archived (PDF) from the original on 2021-03-25. Retrieved 2021-04-13.*
51. ^ ***a b*** WHO (2023) Burden of disease attributable to unsafe drinking-water, sanitation and hygiene, 2019 update. Geneva: World Health Organization; 2023. Licence: CC BY-NC-SA 3.0 IGO.
52. **^** *"Goal 6: Ensure access to water and sanitation for all". Archived from the original on 2019-04-16. Retrieved 2017-11-17.*
53. **^** *UN. "Water and Sanitation". United Nations Sustainable Development. Archived from the original on 2019-04-16. Retrieved 2021-01-04.*
54. **^** *Kurian, Mathew; McCarney, Patricia, eds. (2010). Peri-urban Water and Sanitation Services. Springer. doi:10.1007/978-90-481-9425-4. ISBN 978-90-481-9424-7. Archived from the original on 2022-12-11. Retrieved 2017-09-11.*
55. **^** *Abellán, Javier; Alonso, José Antonio (2022). "Promoting global access to water and sanitation: A supply and demand perspective". Water Resources and Economics.* ***38*** *100194. Bibcode:2022WRE....3800194A. doi:10.1016/j.wre.2022.100194. S2CID 246261266.*
56. **^** WHO and UNICEF types of improved drinking-water source on the JMP website, WHO, Geneva and UNICEF, New York, accessed on June 10, 2012
57. **^** BMGF (2012). Reinvent the Toilet Challenge Archived 2022-11-11 at the Wayback Machine (RTTC, Round 1 and 2), Grand Challenges Explorations (Round 6 and 7) - Request for proposals, grant conditions, Seattle exhibition fair program and exhibitor guide. Bill & Melinda Gates Foundation, Seattle, USA
58. **^** BMGF (2015). Building demand for sanitation - a 2015 portfolio update and overview - Water, sanitation, and hygiene strategy Archived 2022-11-12 at the Wayback Machine, June 2015. Bill & Melinda Gates Foundation, Seattle, Washington, USA
59. **^** Spuhler, D., McCreary, C., Fogde, M., Jenssen, P. D. (2012). Capacity development for sustainable sanitation - Factsheet of Working Group 1 Archived 2022-08-13 at the Wayback Machine. Sustainable Sanitation Alliance (SuSanA)

60. **^** *"About SCBP | SCBP". www.niua.org. Archived from the original on 2021-08-03. Retrieved 2021-06-09.*
61. **^** Kapur, D. (2020) UNDERSTANDING EFFECTIVENESS OF CAPACITY DEVELOPMENT: Lessons from Sanitation Capacity Building Platform, Part 1: Journey of Urban Sanitation Capacity Development in India Archived 2022-01-19 at the Wayback Machine, National Institute of Urban Affairs (NIUA), India
62. ^ ***a b c*** Kapur, D. (2021) UNDERSTANDING EFFECTIVENESS OF CAPACITY DEVELOPMENT : Lessons from Sanitation Capacity Building Platform (SCBP), Part III : Capacity Development Effectiveness Ladder (CDEL) Framework Archived 2022-01-20 at the Wayback Machine, NATIONAL INSTITUTE OF URBAN AFFAIRS, India
63. **^** Jyoti Dash and Depinder Kapur (2021) UNDERSTANDING EFFECTIVENESS OF CAPACITY DEVELOPMENT : Lessons from Sanitation Capacity Building Platform (SCBP) Part II : Sanitation Capacity Building Platform: Understanding the Process and Effectiveness Archived 2021-09-20 at the Wayback Machine
64. ^ ***a b*** *Daudey, Loïc (2018). "The cost of urban sanitation solutions: a literature review". Journal of Water Sanitation and Hygiene for Development.* ***8*** *(2): 176–195. Bibcode:2018JWSHD...8..176D. doi:10.2166/washdev.2017.058. ISSN 2043-9083.*
65. **^** *Patel, Sheela (2015-04-01). "The 20-year sanitation partnership of Mumbai and the Indian Alliance". Environment and Urbanization.* ***27*** *(1): 55–72. Bibcode:2015EnUrb..27...55P. doi:10.1177/0956247815569698. ISSN 0956-2478. S2CID 110444813.*
66. **^** *"The Art of Plumbing as Recorded through History". www.academia.edu. Archived from the original on 2020-04-09. Retrieved 2016-03-10.*
67. **^** Farnsworth Gray, Harold. "Sewerage in Ancient and Mediaeval Times." Sewage Works Journal Vol.12.5 (1940): 939–46

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- Sustainable Sanitation Alliance
- Sanitation and Wastewater Atlas of Africa
- Florence Nightingale (1863), *Sanitary Statistics of Native Colonial Schools and Hospitals*

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Public health

General

- Auxology
- Biological hazard
- Chief medical officer
- Cultural competence
- Deviance
- Environmental health
- Eugenics
    - History of
    - Liberal
- Euthenics
- Genomics
- Globalization and disease
- Harm reduction
- Health economics
- Health literacy
- Health policy
    - Health system
    - Health care reform
- Housing First
- Human right to water and sanitation
- Management of depression
    - Public health law
    - National public health institute
- Health politics
- Labor rights
- Maternal health
- Medical anthropology
- Medical sociology
- Mental health (Ministers)
- Occupational safety and health
- Pharmaceutical policy
- Pollution
    - Air
    - Water
    - Soil
    - Radiation
    - Light
- Prisoners' rights
- Public health intervention
- Public health laboratory
- Right to food
- Right to health
- Right to a healthy environment
- Right to housing
- Right to rest and leisure
- Right to sit
- Security of person
- Sexual and reproductive health

Preventive healthcare

- Behavior change
  - Theories
- Drug checking
- Family planning
- Harm reduction
- Health promotion
- Human nutrition
  - Healthy diet
  - Preventive nutrition
- Hygiene
  - Food safety
  - Hand washing
  - Infection control
  - Oral hygiene
- Needle and syringe programmes
- Occupational safety and health
  - Human factors and ergonomics
  - Hygiene
  - Controlled Drugs
  - Injury prevention
  - Medicine
  - Nursing
- Patient safety
  - Organization
- Pharmacovigilance
- Reagent testing
- Safe sex
- Sanitation
  - Emergency
  - Fecal–oral transmission
  - Open defecation
  - Sanitary sewer
  - Waterborne diseases
  - Worker
- School hygiene
- Smoking cessation
- Supervised injection site
- Vaccination
- Vector control

Population health	○ Biostatistics
	○ Child mortality
	○ Community health
	○ Epidemiology
	○ Global health
	○ Health impact assessment
	○ Health system
	○ Infant mortality
	○ Open-source healthcare software
	○ Multimorbidity
	○ Public health informatics
	○ Social determinants of health
	    ○ Commercial determinants of health
	    ○ Health equity
	    ○ Race and health
	○ Social medicine

Biological and epidemiological statistics	○ Case–control study
	○ Randomized controlled trial
	○ Relative risk
	○ Statistical hypothesis testing
	    ○ Analysis of variance (ANOVA)
	    ○ Regression analysis
	    ○ ROC curve
	    ○ Student's *t*-test
	    ○ *Z*-test
	○ Statistical software

Infectious and epidemic disease prevention	○ Asymptomatic carrier
	○ Epidemics
	    ○ List
	○ Notifiable diseases
	    ○ List
	○ Public health surveillance
	    ○ Disease surveillance
	○ Quarantine
	○ Sexually transmitted infection
	○ Social distancing
	○ Tropical disease
	○ Vaccine trial
	○ WASH

Food hygiene and safety management	○ Food
	  ○ Additive
	  ○ Chemistry
	  ○ Engineering
	  ○ Microbiology
	  ○ Processing
	  ○ Safety
	  ○ Safety scandals
	○ Good agricultural practice
	○ Good manufacturing practice
	  ○ HACCP
	  ○ ISO 22000

Health behavioral sciences	○ Diffusion of innovations ○ Health belief model ○ Health communication ○ Health psychology ○ Positive deviance ○ PRECEDE–PROCEED model ○ Social cognitive theory ○ Social norms approach ○ Theory of planned behavior ○ Transtheoretical model

Organizations, education and history

Organizations

- Caribbean
  - Caribbean Public Health Agency
- China
  - Center for Disease Control and Prevention
- Europe
  - Centre for Disease Prevention and Control
  - Committee on the Environment, Public Health and Food Safety
- Russia
  - Rospotrebnadzor
- India
  - Ministry of Health and Family Welfare
- Canada
  - Health Canada
  - Public Health Agency
- U.S.
  - Centers for Disease Control and Prevention
  - Health departments in the United States
  - Council on Education for Public Health
  - Public Health Service
- World Health Organization
- World Toilet Organization
- (Full list)

Education

- Health education
- Higher education
  - Bachelor of Science in Public Health
  - Doctor of Public Health
  - Professional degrees of public health
  - Schools of public health

History

- History of public health in the United Kingdom
- History of public health in the United States
- History of public health in Australia
- Sara Josephine Baker
- Samuel Jay Crumbine
- Carl Rogers Darnall
- Joseph Lister
- Margaret Sanger
- John Snow
- Typhoid Mary
- Radium Girls
- Germ theory of disease
- Social hygiene movement

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