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Sewage treatment Save Sewage treatment is the process of removing contaminants from municipal wastewater , containing mainly household sewage plus some industrial wastewater. Physical, chemical, and biological processes are used to remove contaminants and produce treated wastewater or treated effluent that is safe enough for release into the environment. A by-product of sewage treatment is a semi-solid waste or slurry, called sewage sludge. The sludge has to undergo further treatment before being suitable for disposal or application to land. Sewage treatment may also be referred to as wastewater treatment. However, the latter is a broader term which can also refer to industrial wastewater. For most cities, the sewer system will also carry a proportion of industrial effluent to the sewage treatment plant which has usually received pre-treatment at the factories themselves to reduce the pollutant load. If the sewer system is a combined sewer then it will also carry urban runoff stormwater to the sewage treatment plant. Sewage water can travel towards treatment plants via piping and in a flow aided by gravity and pumps. The first part of filtration of sewage typically includes a bar screen to filter solids and large objects which are then collected in dumpsters and disposed of in landfills. Fat and grease is also removed before the primary treatment of sewage. Terminology The term "sewage treatment plant" or "sewage treatment works" in some countries is nowadays often replaced with the term wastewater treatment plant or wastewater treatment station. 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. Origins of sewage Sewage is generated by residential, institutional, commercial and industrial establishments. It includes household waste liquid from toilets , baths , showers , kitchens , and sinks draining into sewers. In many areas, sewage also includes liquid waste from industry and commerce. The separation and draining of household waste into greywater and blackwater is becoming more common in the developed world, with treated greywater being permitted to be used for watering plants or recycled for flushing toilets. Sewage mixing with rainwater Sewage may include stormwater runoff or urban runoff. Sewerage systems capable of handling storm water are known as combined sewer systems. This design was common when urban sewerage systems were first developed, in the late 19th and early 20th centuries. Heavy volumes of storm runoff may overwhelm the sewage treatment system, causing a spill or overflow. Sanitary sewers are typically much smaller than combined sewers, and they are not designed to transport stormwater. Communities that have urbanized in the midth century or later generally have built separate systems for sewage sanitary sewers and stormwater, because precipitation causes widely varying flows, reducing sewage treatment plant efficiency. Some jurisdictions require stormwater to receive some level of treatment before being discharged directly into waterways. Examples of treatment processes used for stormwater include retention basins , wetlands , buried vaults with various kinds of media filters , and vortex separators to remove coarse solids. This process is called industrial wastewater treatment or pretreatment. The same does not apply to many developing countries where industrial effluent is more likely to enter the sewer if it exists, or even the receiving water body, without pretreatment. Industrial wastewater may contain pollutants which cannot be removed by conventional sewage treatment. Also, variable flow of industrial waste associated with production cycles may upset the population dynamics of biological treatment units, such as the activated sludge process. Process steps Overview Sewage collection and treatment is typically subject to local, state and federal regulations and standards. Treating wastewater has the aim to produce an effluent that will do as little harm as possible when discharged to the surrounding environment, thereby preventing pollution compared to releasing untreated wastewater into the environment. Primary treatment consists of temporarily holding the sewage in a quiescent basin where heavy solids can settle to the bottom while oil, grease and lighter solids float to the surface. The settled and floating materials are removed and the remaining liquid may be discharged or subjected to secondary treatment. Some sewage treatment plants that are connected to a combined sewer system 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 stormwater only receives primary treatment. Secondary treatment removes dissolved and suspended biological matter. Secondary treatment is typically performed by indigenous , water-borne micro-organisms in a managed habitat. Secondary treatment may require a separation process to remove the micro-organisms from the treated water prior to discharge or tertiary treatment. Tertiary treatment is sometimes defined as anything more than primary and secondary treatment in order to allow ejection into a highly sensitive or fragile ecosystem estuaries, low-flow rivers, coral reefs, 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, green way or park. If it is sufficiently clean, it can also be used for groundwater recharge or agricultural purposes. Simplified process flow diagram for a typical large-scale treatment plant Process flow diagram for a typical treatment plant via subsurface flow constructed wetlands SFCW Pretreatment Pretreatment removes all materials that can be easily collected from the raw sewage before they damage or clog the pumps and sewage lines of primary treatment clarifiers. Objects commonly removed during pretreatment include trash, tree limbs, leaves, branches, and other large objects. The influent in sewage water passes through a bar screen to remove all large objects like cans, rags, sticks, plastic packets etc. 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. It also includes organic matter such as eggshells, bone chips, seeds, and coffee grounds. Pretreatment may include a sand or grit channel or chamber, where the velocity of the incoming sewage is adjusted to allow the settlement of sand and grit. Grit removal is necessary to 1 reduce formation of heavy deposits in aeration tanks, aerobic digesters, pipelines, channels, and conduits; 2 reduce the frequency of digester cleaning caused by excessive accumulations 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 diaphram pumps. Grit chambers come in 3 types: Vortex type 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. During periods of high flow deposited grit is resuspended and the quantity of grit reaching the treatment plant increases substantially. It is, therefore important that the grit removal system not only operate efficiently during normal flow conditions but also under sustained peak flows when the greatest volume of grit reaches the plant. Equalization basins may be used for temporary storage of diurnal or wet-weather flow peaks. Basins provide a place to temporarily hold incoming sewage during plant maintenance and a means of diluting and distributing batch discharges of toxic or high-strength waste which might otherwise inhibit biological secondary treatment including portable toilet waste, vehicle holding tanks, and septic tank pumpers. Flow equalization basins require variable discharge control, typically include provisions for bypass and cleaning, and may also include aerators. Cleaning may be easier if the basin is downstream of screening and grit removal. 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 Primary treatment tanks in Oregon, USA In the primary sedimentation stage, sewage flows through large tanks, commonly called "pre-settling basins", "primary sedimentation tanks" or "primary clarifiers ". 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. Secondary treatment Secondary treatment is designed to substantially degrade the biological content of the sewage which are derived from human waste, food waste, soaps and detergent. The majority of municipal plants treat the settled sewage liquor using aerobic biological processes. To be effective, the biota require both oxygen and food to live. The bacteria and protozoa consume biodegradable soluble organic contaminants e. Secondary treatment systems are classified as fixed-film or suspended-growth systems. Fixed-film or attached growth systems include trickling filters , constructed wetlands , bio-towers, and rotating biological contactors , where the biomass grows on media and the sewage passes over its surface. However, fixed-film systems are more able to cope with drastic changes in the amount of biological material and can provide higher removal rates for organic material and suspended solids than suspended growth systems. Tertiary treatment The purpose of tertiary treatment is to provide a final treatment stage to further improve the effluent quality before it is discharged to the receiving environment sea, river, lake, wet lands, ground, etc. More than one tertiary treatment process may be used at any treatment plant. If disinfection is practised, it is always the final process. It is also called "effluent polishing. These lagoons are highly aerobic and colonization by native macrophytes , especially reeds, is often encouraged. Small filter-feeding invertebrates such as Daphnia and species of Rotifera greatly assist in treatment by removing fine particulates. Biological nutrient removal Biological nutrient removal BNR is regarded by some as a type of secondary treatment process,[2] and by others as a tertiary or "advanced" treatment process. Wastewater may contain high levels of the nutrients nitrogen and phosphorus. Excessive release to the environment can lead to a buildup of nutrients, called eutrophication , which can in turn encourage the overgrowth of weeds, algae , and cyanobacteria blue-green algae. This may cause an algal bloom , a rapid growth in the population of algae. The algae numbers are unsustainable and eventually most of them die. The decomposition of the algae by bacteria uses up so much of the oxygen in the water that most or all of the animals die, which creates more organic matter for the bacteria to decompose. In addition to causing deoxygenation, some algal species produce toxins that contaminate drinking water supplies. Different treatment processes are required to remove nitrogen and phosphorus. Nitrogen removal 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. Denitrification requires anoxic conditions to encourage the appropriate biological communities to form. It is facilitated by a wide diversity of bacteria. Sand filters, lagooning and reed beds can all be used to reduce nitrogen, but the activated sludge process if designed well can do the job the most easily. This can be, depending on the waste water, organic matter from feces , 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 [RAS], and raw influent e. Sometimes the conversion of toxic ammonia to nitrate alone is referred to as tertiary treatment. Over time, different treatment configurations have evolved as denitrification has become more sophisticated. An initial scheme, the Ludzackâ€”Ettinger Process, placed an anoxic treatment zone before the aeration tank and clarifier, using the return activated sludge RAS from the clarifier as a nitrate source. Influent wastewater either raw or as effluent from primary clarification serves as the electron source for the facultative bacteria to metabolize carbon, using the inorganic nitrate as a source of oxygen instead of dissolved molecular oxygen. This denitrification scheme was naturally limited to the amount of soluble nitrate present in the RAS.

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