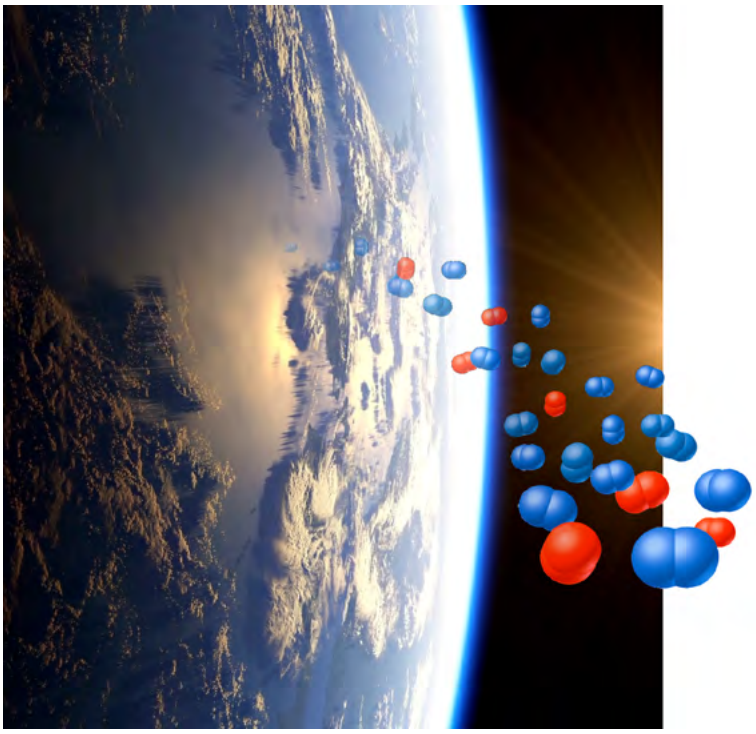


Chapter 16

Water and Air Resources

THE MAIN IDEA

The Earth is huge, but so is our ability to transform the environment.

16.4 Wastewater Treatment

The contents of the sewer systems that underlie most municipalities must be treated before being released into a body of water. The level of treatment depends in great part on whether the treated water is to be released into a river or into the ocean. Wastewater destined for a river requires the highest level of treatment for the benefit of communities downstream.

Human waste loses its form by the time it reaches the wastewater facility, and the wastewater appears as a murky stream. In this stream, however, are many insoluble products—including small plastic items and gritty material such as coffee grounds. Hardened balls of grease from discarded cooking fats are also found (Please do not dispose cooking oil down the drain!). The initial step in all wastewater treatments, therefore, involves the screening out of these insolubles. (You should know that wastewater treatment experts point out that these insolubles—even cooking grease—should be disposed of as solid waste and **not** be washed down the drain or flushed down the toilet.)

After screening, which may include the use of a grit chamber, the next level of municipal wastewater treatment is *primary* treatment. In primary treatment, screened wastewater enters a large settling basin, where suspended solids settle out as sludge (**Figure 16.12**). After a period of time, the sludge is removed from the bottom of the settling basin and is often sent directly to a landfill as solid wastes. Some facilities, however, are equipped with large furnaces in which dried sludge is burned, sometimes along with other municipal wastes such as paper products. The resulting ash is more compact and takes up less space in a landfill.

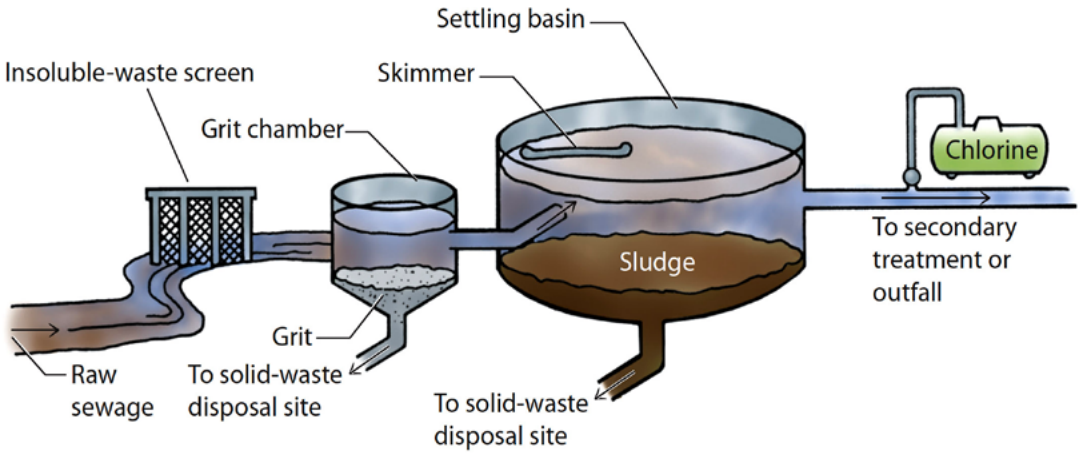
Wastewater effluent from primary treatment, as well as higher levels of treatment, is commonly disinfected with either chlorine gas or ozone prior to its release into the environment. A great advantage of using chlorine gas

FOR YOUR INFORMATION

In Hong Kong, about 80 percent of all toilets flush using seawater. Developed since the 1960s, this system now saves the equivalent of about 25 percent of fresh water consumption. Also, effluent from fresh water activities, such as personal hygiene and dishwashing, is treated and reused for watering city trees..

READING CHECK

What happens to the solids of wastewater during primary treatment?

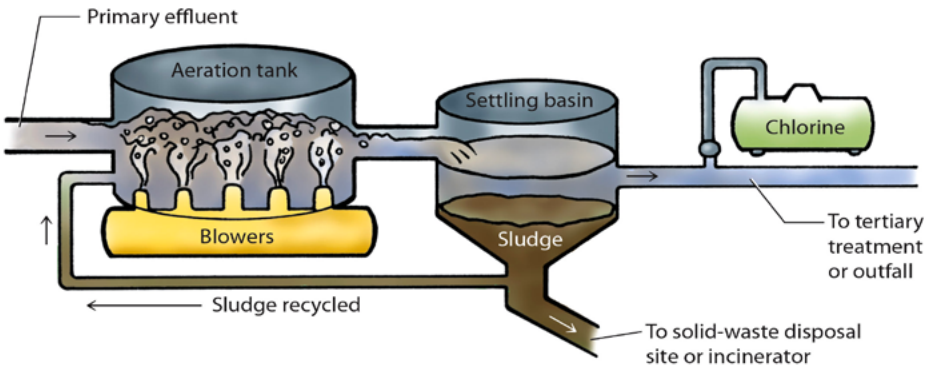


Λ Figure 16.12

A schematic for primary level wastewater treatment. The rotating skimmer on the settling basin is used to remove buoyant materials and artifacts not captured by the screening process.

is that it remains in the water for an extended time after leaving the facility. This provides for residual protection against diseases. The chlorine, however, reacts with organic compounds within the effluent to form chlorinated hydrocarbons, many of which are known carcinogens (cancer-causing agents). Also, chlorine kills only bacteria, leaving viruses unharmed. Ozone is more advantageous in that it kills both bacteria and viruses. Also, there are no carcinogenic by-products that result from treating wastewater effluent with ozone. A disadvantage of ozone, however, is that it provides no residual protection for the effluent once it is released. Most facilities in the United States use chlorine for disinfecting, whereas European facilities tend to favor ozone. In some locations, chlorine and ozone gases have been replaced by strong ultraviolet lamps, which, like ozone, kill both bacteria and viruses but provide no long-term residual protection.

The potential for pathogens to grow in primary effluent is extremely high, and by virtue of the Clean Water Act of 1972, the release of primary effluent is not permitted in most places. A frequently used *secondary* level of treatment, shown in **Figure 16.13**, involves first passing the primary effluent through an aeration tank. This supplies the oxygen necessary for continued decomposition of organic matter by oxygen-dependent aerobic bacteria. The effluent is then sent into a tank where any fine particles not removed in primary treatment can settle. Because sludge from this settling step is high in aerobic bacteria, some of it is recycled back to the aeration tank to increase efficiency. The remainder of the sludge is hauled off to a landfill or an incinerator.



< Figure 16.13

A schematic for secondary treatment of wastewater from a municipal system.

FOR YOUR INFORMATION

For dwellings in remote locations such as summer cabins, many people are opting for composting toilets, which use no water. Rather, they allow human waste to decompose aerobically (with oxygen) as air is vented over the waste, which is buried in peat moss. Dried, odor-free compost, which is removed every few months, is useful as a garden fertilizer.

Many municipalities also require a third level, a *tertiary* level, of wastewater treatment. There are a number of tertiary processes, and most involve filtration of some sort. A common method is to pass secondary-level effluent through a bed of finely powdered carbon, which captures most of the particulate matter and many of the organic molecules not removed in earlier stages. The advantage of tertiary-level treatment is greater protection of our water resources. Unfortunately, tertiary treatment is costly and is normally used only in situations in which the need is deemed vital. Primary and secondary levels of treatment are also not without great cost.

CONCEPT **CHECK**

Distinguish among the main functions of primary, secondary, and tertiary wastewater treatment.

CHECK YOUR ANSWER Primary wastewater treatment removes the bulk of solid waste and sludge from the sewage effluent using screening devices and large settling basins. Secondary treatment provides oxygen to oxygen dependent bacteria that serve to decompose organic matter. Tertiary treatment removes pathogens and wastes not removed by earlier treatments by filtering the effluent through beds of powdered carbon or other fine particles.