



APES in a BOX: The Review Sessions

Sewage Treatment and Solid Waste Management

THERE IS NO AWAY! With that in mind, let's take a look at what happens to your waste when you throw away your garbage or flush your toilet.

Wastewater Treatment

Every day millions of Americans flush their toilet, and don't give a second thought to the final destination of the toilets contents. While it might be nice to imagine the waste completely disappearing once it is out of site, in reality treating wastewater is a complicated process with a solid waste problem waiting at the end of it. Wastewater travels from the toilet, through sewer lines, and ultimately ends up at a wastewater treatment facility. The wastewater treatment process can usually be broken down into primary treatment, secondary treatment, and tertiary treatment.

In **primary treatment** (a physical process) large objects (use your imagination) are removed from the wastewater with large screens. As the water flows through the screens, the objects are filtered out. The resulting solid garbage must be disposed of in a landfill. The water is then diverted to settling tanks where remaining particulate matter is allowed to settle out of the water. The water is then sent to secondary treatment.

In **secondary treatment** (a biological process) the wastewater is mixed with oxygenated water. This encourages the bacterial breakdown of the organic matter left in the wastewater. The bacteria and particulate matter settle out of the water creating sewage sludge. The sludge is removed, dried, and then either disposed of in landfills, incinerated, or used for fertilizer. The water is then disinfected using chlorine, ozone, or UV light. In some cities, the water is then put through tertiary treatment.

Tertiary treatment involves using physical or chemical methods to remove inorganic nutrients such as nitrogen or phosphorus from the water. Removing these chemicals will help combat eutrophication in areas where the water is discharged.

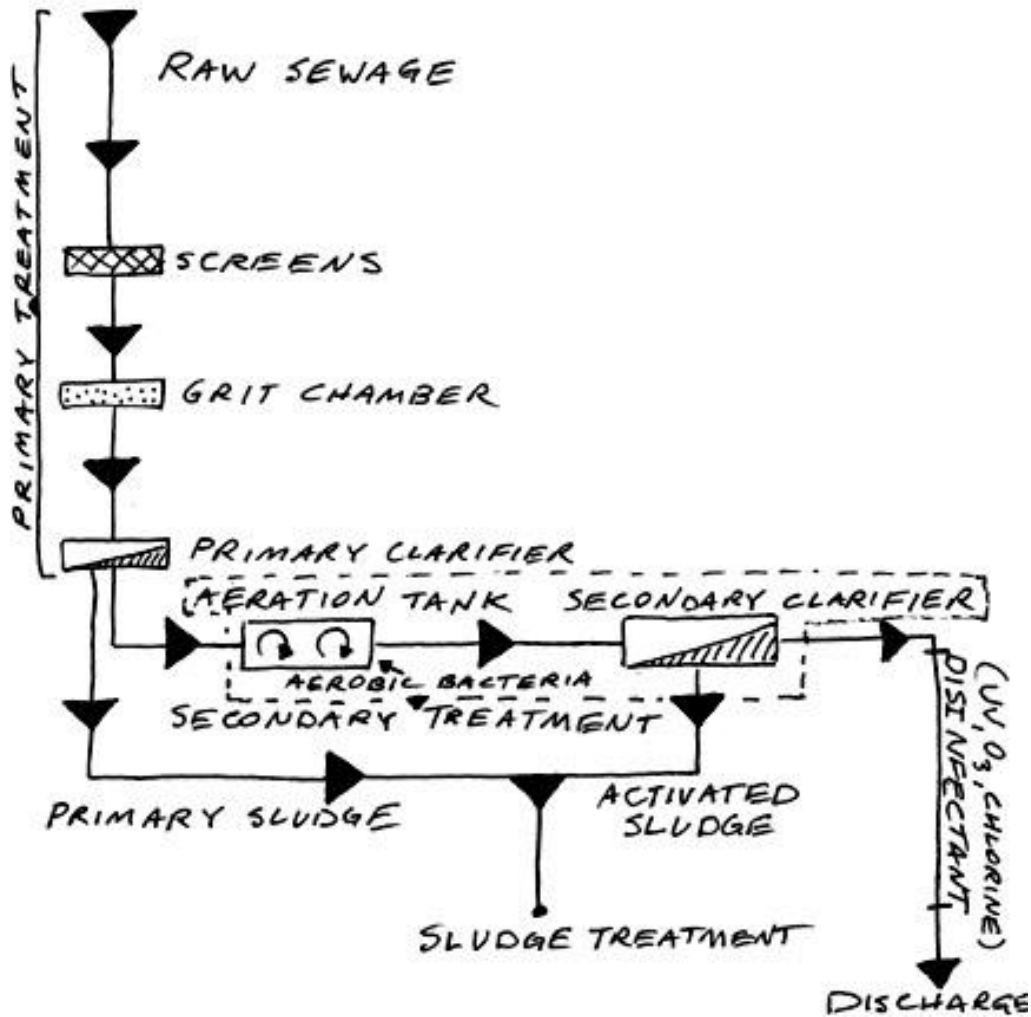
In rural areas where it doesn't make sense to build a wastewater treatment plant, residents rely on septic systems which serve as individual wastewater treatment plants. Sewage from a home is held in an underground tank where it is broken down by bacteria. The leftover water is allowed to leach into the soil through underground pipes. In newer systems, the water is disinfected and used for lawn irrigation.

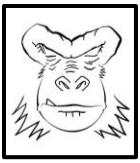


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In many areas, city planners are looking to nature for innovation in wastewater treatment. There have been several facilities built that pass sewage through artificial wetlands. This allows gravity and biological processes to treat the sewage, with little to no negative impact.

Sewage Treatment





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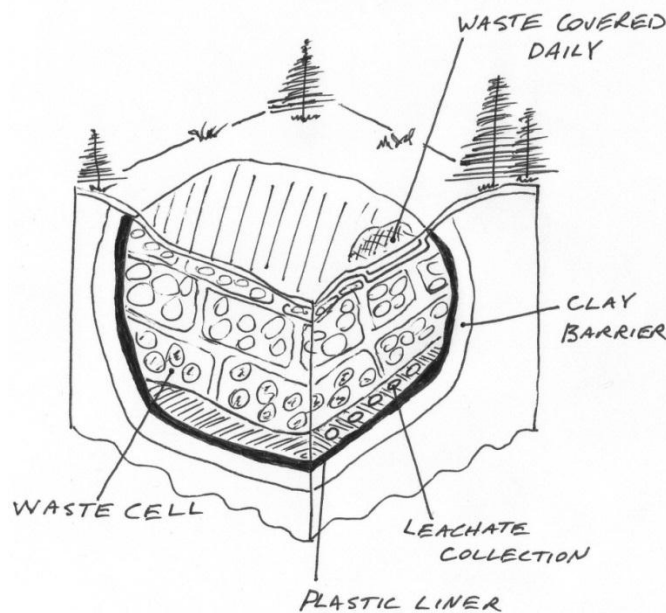
Landfills

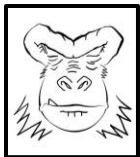
Now that we have dealt with your toilet, let's take a look at what happens to the trash that you throw out each day. After pickup by the garbage man, the fate of your garbage most likely lies in a landfill or incinerator.

Most of the municipal waste in the United States ends up in landfills. The simplest form of landfilling involves collecting and dumping trash in open piles. The piles are then left to decompose or sometimes burned to make space. This was practiced for a long time in the United States. The problem with a giant pile of trash is that any of the pollutants in the trash are free to runoff. The trash heap is also a prime habitat for rodents and other disease vectors. In the U.S., this method has been predominantly replaced with sanitary landfills. **Sanitary landfills** involve burying trash in a pit that has a clay bottom and sides and a plastic liner. The trash is layered with soil. The soil helps the trash decompose faster, and helps keep animals out of the trash. When the landfill is full, it is covered with plastic, clay, and topsoil. The retired landfill can then be used for further development. There have been many city parks built on top of old landfills.

When rain soaks through a landfill, the resulting contaminated liquids are called **leachate**. Sanitary landfills have a leachate collection system that runs beneath the landfill, and groundwater is continuously monitored to make sure that the leachate is not seeping into the groundwater.

Sanitary Landfill





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Incineration

In some areas, waste is incinerated to reduce the burden on landfills. When garbage enters an incineration facility, the metals are usually removed, and the garbage is shredded. The garbage is then burned at very high temperatures. The left over liquid and ash must be treated and buried in a landfill. The ash can contain many toxic chemicals such as heavy metals or dioxin. The emissions from the incineration plant must pass through a scrubber to remove air pollutants such

as sulfur dioxide. Incineration drastically reduces the volume of trash that is placed into landfills. In waste-to-energy incinerators, the heat that is generated by burning trash is used to create steam. The steam is then used to spin a turbine attached to a generator. Electricity is then produced in the same way as most other power plants.

Reduce, Reuse, Recycle

“Reduce, Reuse, Recycle...” isn’t just a catchy line from a Jack Johnson song. The “three R’s” play an important role in reducing the total volume of garbage. Our first priority in waste reduction should be to reduce. **Reducing** involves purchasing goods that have less packaging material, repairing instead of replacing, and using products for their full lives instead of making unnecessary upgrades. Yes, this is directed to those of you who buy a new cell phone every six months!

Reusing involves simple actions like reusing plastic bags, cardboard boxes, avoiding disposable items, etc... It could also mean buying a used car instead of that new one that you have had your eye on. Both reducing and reusing result in less waste entering the waste stream.

After we have cut down our waste generation by reducing and reusing it is important to **recycle** whatever we can prior to sending garbage to a landfill. Recycling generally involve a local facility where citizens can drop off metals, plastics, and paper. Many cities have curbside recycling where garbage trucks pick up the recyclables and take them to a **Materials Recovery Facility**. Here the materials are sorted and sent to manufacturers who use the waste as raw materials for new products. Recycling must be economically feasible for cities to continue to invest in recycling programs. It is therefore important to support companies who offer products made of recycled materials.



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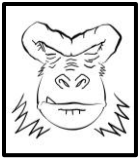
The Fine Print

The **Pollution Prevention Act** focuses on the prevention of pollution through reduction of waste, pollution, and inefficiency at the source.

The **Resource Conservation and Recovery Act (RCRA)** allows the EPA to regulate the handling, storage, and disposal of hazardous waste.

The **Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)** created a federal "superfund" that would be used to clean up abandoned hazardous waste, or emergency discharges of hazardous waste. This is often called the **Superfund Act**.

The **Toxic Substances Control Act** allows the EPA to keep track of industrial chemicals produced or imported into the United States.



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Sewage and Solid Waste Review Questions

1. Which of the following best describes what occurs during secondary treatment?
 - A) Biological process
 - B) Chemical process
 - C) Physical process
 - D) B and C only
 - E) A, B, and C equally describe secondary treatment

2. Which of the following terms refers to the contaminated fluid that leaks through landfills?
 - A) Runoff
 - B) Eutrophication
 - C) Leachate
 - D) Sedimentation
 - E) Sewer Sludge

3. Which of the following environmental laws is often referred to as the "Superfund Act", and identifies and prioritizes cleanup of hazardous waste sites in the United States?
 - A) Pollution Prevention Act
 - B) Resource Conservation and Recovery Act
 - C) CERCLA
 - D) Toxic Substances Control Act
 - E) Copenhagen Protocol



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4. Which of the following pieces of environmental legislation allows the EPA to keep track of industrial chemicals produced or imported into the United States?
- A) Pollution Prevention Act
 - B) Resource Conservation and Recovery Act
 - C) CERCLA
 - D) Toxic Substances Control Act
 - E) Copenhagen Protocol

Free Response

1. Every day millions of gallons of wastewater leave households all across the world. This water must be treated prior to being released back into the environment.

A. Identify the type of materials that are removed from wastewater during primary treatment, and describe how those materials are removed.

B. Identify the type of materials that are removed from wastewater during secondary treatment, and describe how those materials are removed.

C. Identify one chemical that is removed during tertiary treatment of wastewater.



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Multiple Choice Scoring Guidelines

1. A	3. C
2. C	4. D

Free Response Scoring Guidelines

1.A. (2pts total) 1pt each for correct identification as solids being removed by primary treatment, and for a description of physical screening as the process that removes the solids.

1.B. (2pts total) 1pt each for correct identification as organic waste as the material that is being removed by secondary treatment, and for a description of decomposition by bacteria as the method of removal.

1.C. (1pt total) 1pt for the identification of an inorganic chemical such as phosphorus or nitrogen.

Multiple choice points earned + Free response points earned / 9 * 100= Quiz average

(_____ + _____) / 9 * 100 = _____ Quiz Grade