Lesson Plan – Week 4 – July 23 –July 25
The Urban Water Cycle and the Urban Watershed
Two and One-Half Hours

Goals

- Students will learn the basics of drinking water treatment
- Students will learn the basics of wastewater treatment
- Students will become familiar with the processes of the urban water cycle
- Students will gain an understanding of how the urban watershed mimics the natural watershed
- Students will learn how pollution occurs in an urban watershed

Objectives

- Students will review glossary of key words for this week's lesson
- Students will learn the processes of the urban water cycle through the use of an urban water cycle chart and illustration
- Students will learn how their homes and school is connected to the urban water cycle through a household plumbing diagram and illustration
- Students will review old stream maps and sewer plan maps of Mill Creek to discuss the comparisons between natural watersheds and urban watersheds
- Students will demonstrate how stormwater runoff carries away pollutants by using the urban watershed model

Related Activities for the Lesson

Activity #2 – Collection and tagging of urban artifacts at vacant lot – Students will uncover buried bottles, bricks and other debris at the site and discuss their probable origin. Artifacts will be tagged and placed in a container for cataloguing.

Activity # 8 – Students will begin designing the urban water cycle mural to be installed at the vacant lot.

Activity #11– Visit to the Belmont Drinking Water Treatment Plant (July 25).

Glossary of Watershed Project Terms

Add to last week's glossary

Aerobic: Requiring oxygen or air to live.

Anaerobic: Able to live without free oxygen.

Bacteria: A germ; a unicellular microorganism. Bacteria occur in a variety of forms, environments, and with a wide range of properties, often pathogenic.

Chlorine: A gaseous halogen and bleaching agent, used widely as a disinfectant to purify water.

Collection: The process in wastewater treatment where stormwater and sanitary sewage are drained from houses and streets and conducted via sewers to a wastewater treatment plant.

Compost: A nutrient-rich mixture of decayed organic material, such as leaves and manure, used as a fertilizer.

Disinfection: The final stage of water and wastewater treatment. Chlorine or sodium hypochloride is added to kill any leftover bacteria before the treated water is distributed or returned to the river.

Filtration: The process by which water is passed through a porous substance in order to remove constituents such as suspended particles. In drinking water treatment, water flows through filters of sand, charcoal and gravel.

Fluoride: A chemical that is added to drinking water before distribution to prevent tooth decay in children.

Microorganism (microbe): A plant or animal of microscopic size, such as a bacterium or protozoa.

Pathogen: Any agent, such as bacterium, that causes disease.

Preliminary treatment: The initial stages of wastewater treatment where large objects are removed at the bar screens and in the grit chamber. Logs, soda cans, and fast food containers are caught and removed at the bar screens. Smaller objects such as cigarette butts, gravel, and bits of plastic get trapped as the water passes through the grit chamber.

Primary treatment: In wastewater treatment, after the water passes through preliminary treatment, the water is slowed down to allow light objects such as oils to rise to the surface and to let heavier materials such as waste and food to sink to the bottom (sludge). At the end of primary treatment, the scum and sludge are scraped off and removed.

Pollution: An alteration in the character of the quality of the environment, such as physical, chemical or biological properties of water by a substance (pollutant) that makes the water harmful to use.

Reservoir: A body of water stored for public use. In the water treatment process, water enters reservoirs where it slows down and some particles settle out. This is the first stage of treatment. Once water has been cleaned, it is stored in reservoirs until needed.

Secondary treatment: In wastewater treatment, after primary treatment, dissolved and suspended solids remain in the wastewater. Microorganisms are added to the water along with oxygen to feed on the particles. These are the same microbes that decompose sewage in nature. As they eat, they get heavy and sink out of the water and are reused.

Sedimentation: Settling; the act or process of depositing material.

Sludge: The material that settles to the bottom of the tanks in primary wastewater treatment. The sludge is pumped to the Water Department's Biosolids Recycling Center where it is composted into a fertilizer product.

Water treatment: The cleansing of – or removal of pollutants from – water. Drinking water is river water or groundwater that has been cleaned for human use. Wastewater enters a treatment plant from sewers and is cleaned before it is returned to a waterway.

Wastewater: Polluted water. The water entering a wastewater treatment plant is a combination of sewage (organic debris) and wastewater (inorganic debris).

Lesson Narrative

Drinking Water

Water is vital to all living things because it is essential to the creation and functioning of living cells. Water helps to shape our social environment as well as our physical environment. Water's quality and location determine, to a great extent, human population centers, sources of energy, modes of transportation and recreational activities.

For many years people did not realize that water could contain bacteria and viruses which cause disease and death. During the 18th century, Philadelphians relied on underground wells for their water. When their cesspools and drains leaked sewage into their wells, the city's leaders, including Benjamin Franklin, sought an alternate source of drinking water. By the turn of that century, the city decided to obtain its drinking water from the Schuylkill River.

Today, Philadelphians get all their drinking water from the Delaware and Schuylkill rivers. To remove disease-causing bacteria as well as any dirt and other pollutants that can make water unpleasant or unhealthy to drink, river water must be cleaned at one of the three drinking water treatment plants in the city.

The drinking water treatment process involves the following steps:

1. Screening to remove debris
2. Natural sedimentation in reservoirs during which large particles settle to the bottom

3. The addition of chemicals which create an attraction among smaller particles so that they clump together and settle to the bottom
4. Filtration during which the very tiny particles are removed
5. Addition of fluoride for teeth protection
6. Chlorination to destroy disease-causing bacteria

Wastewater

Each time water is used to wash our bodies, clothes and cars, or to cook our foods or brush our teeth, we make wastewater. Each time an industry uses water to make paper products, iron, steel and oil, wastewater is produced.

But what exactly is wastewater? Basically, wastewater is all the used water generated by a community, including: human waste flushed down toilets, food scraps washed down sinks, and the water from washing machines, bathtubs, street storm drains and businesses of all kinds. Wastewater, also called sewage, is about 99.94 percent water and only 0.06 percent of actual waste.

All uses and users of water make wastewater, from the child brushing his teeth in the morning to the biggest oil refinery. And with over 20 million people using the Delaware River and its tributaries every day, that's a lot of wastewater.

In Philadelphia, once people have used water, it is collected by a system of sewer pipes that direct the flow into one of the three wastewater treatment plants along the Delaware River.

What happens at these plants is essentially the same as what goes on naturally in a stream or river. However, wastewater treatment plants speed up the natural processes by which water is cleaned. In the natural process, bacteria and other microscopic organisms, e.g., algae, fungi, protozoa, in a stream or river, are attracted to the pollutants in wastewater as a source of food.

In addition to using these same microscopic organisms in the wastewater treatment process, wastewater treatment plants use physical methods of screening and gravity settling to remove debris and other pollutants.

In Philadelphia, wastewater goes through three stages of treatment before it is discharged into the Delaware River. The wastewater treatment process can vary slightly from plant to plant, but typically involves the following steps:

Preliminary Treatment

1. Wastewater flows by gravity into the plant
2. Wastewater is pumped through screens to remove large debris, e.g., sticks and rags
3. Wastewater then flows through basins at a speed that allows heavy inorganics, e.g., sand and gravel, to settle

Primary Treatment

1. Wastewater flows slowly through primary sedimentation tanks where solids that are heavier than water sink to the bottom, as the water continues to flow
2. Scum and grease which float to the top are scraped away
3. The solids that have settled to the bottom, called sludge, are scraped out, concentrated and converted to fertilizer

Secondary Treatment

1. Wastewater is combined with activated sludge, sludge containing the same microorganisms that decompose sewage in nature, to eat the remaining dissolved and suspended solids in the wastewater
2. Pure oxygen is added to promote an oxygen-rich atmosphere and to encourage the microorganisms to eat the wastes. The addition of oxygen ensures that the microorganisms will not consume all the oxygen in the water as they consume the wastes.
3. These microorganisms become fat and heavy after consuming the waste and drop to the bottom of the final settling tanks where they are either scraped out and converted to fertilizer or recycled to feed over and over again on additional wastes.
4. The water is mixed with enough chlorine to kill any remaining disease-producing organisms and returned to the Delaware River.

Water pollution control is one of the best defenses we have against the fouling of our environment by water pollution. This technology is vital to the protection of our limited supply of clean water as a source of drinking water, and as a healthy habitat for fish and other aquatic life.

Urban Watersheds

A watershed is the area of land that drains to a waterway. We all live in a watershed. In Philadelphia, we all live in the Atlantic Ocean watershed, but within each of our neighborhoods there are smaller watersheds that drain into a particular creek, river, or lake.

In the natural watershed, more precipitation such as rainwater infiltrates into the ground where it is cleaned and becomes part of groundwater supplies. In the urban watershed, though, pavement has replaced permeable surfaces, and rainwater cannot sink into the soil. Imagine that you threw trash on the ground, or sprayed chemicals on your garden, or dumped oil down the sewer. When it rains, what happens to these pollutants? They are picked up by the rainwater and flow over your watershed into a body of water. Storm drains and combined sewers are also part of your watershed and they often lead directly to a creek. They are not meant to be trashcans. Items such as trash, chemicals, and oil hurt the natural environment and are called pollutants.

All living things need – *clean* water. What happens if you drink polluted water? You could get sick or even die. In history, may people died from drinking polluted water. This is why we all must take special care of our water resources. The cleaner we keep our rivers, the easier it is for the water to be cleaned. Also, we are not the only creatures that

depend on water for survival. There are many plants and animals that need water too, and all of these organisms help make our environment a healthy place to live.

Discussion Questions

Is it safe to drink water directly from our rivers?
Why not?
How does Philadelphia make the water safe to drink?
Do you know which treatment plant provides your home and school with clean drinking water?

Where does the water go after you use it?
When you wash? When you cook? When you water the lawn?
Is this water clean?
What happens to the water (what is it called now) when it goes to the wastewater treatment plant?
Do you know which wastewater treatment plant receives the water after you use it?

How does the urban water cycle remind you of the natural watershed?
What are the similarities between the two cycles?
What are the differences?

Materials Needed

- Glossary
- Urban Water Cycle (one poster size and handouts)
- Homeowner Plumbing Connections (one poster size and handouts)
- Let's Learn About Water Activity Books
- PWD Urban Watershed Model
- Stormy Weather Video

Student Assessment

I know that ….. I want to know …… I learned that ……..

Have students share with one another (orally) during last half-hour of class.