Lesson W9 Wastewater and CSOs

Where Does our Water Go When We Flush it Down the Drain?

When you flush your toilet or wash your dishes, where does the water go? We learned that only 2-3% of the water used in homes and businesses is used for drinking or cooking. That means that almost all of the water that we use at home goes down the drain. This is the water we use for washing our dishes, flushing our toilets, cleaning our laundry and bathing. This "wastewater" enters our sewer systems, wastewater treatment plants, and, ultimately, our waterways.

The sewer system is an underground network of pipes. Just like streams that carry water, the slope of the pipes carries the water downstream and the pipes increase in size as many smaller pipes flow into larger pipes.

Until the U.S. Clean Water Act was passed, this sewage was often discharged into our streams and rivers. Sewage in a waterbody not only makes our waters very polluted and unsafe to drink, it uses up oxygen as it decomposes. This is harmful for fish and other aquatic life. Even though fish live under water, they need lots of oxygen in the water to breathe!

Today, sewer systems deliver sewage to wastewater treatment plants. Here, wastewater goes through treatment to remove fecal and other wastes before the cleaned effluent is discharged into a waterbody. The sewage typically goes through primary treatment where it passes through a screen to remove trash and large objects and then into chambers and tanks where smaller particles settle out. The next step is secondary treatment where wastewater most commonly flows into large tanks filled with microbes that break down organic wastes, though there are several other processes that may be used. Through these treatment processes, wastewater treatment plants are required to remove 85% of pollutant loads. The water then undergoes disinfection and dechlorination, and typically becomes safe to discharge into waterbodies. But sometimes additional nitrogen removal and other treatment are needed. The solids that are collected through this process are processed in large digester tanks, which act as large stomachs. Once digested, the resulting sludge can be put to beneficial use as fertilizer, if it meets strict contaminant levels. If not, it is typically disposed of at a landfill.

Did you know?

New York City has 14 wastewater treatment plants. The largest plant handles 310 MILLION GALLONS A DAY! There are 7,400 miles of sewers that transport wastewater to the plants. That's longer than the distance from NYC to California and back again!

Photo: wabag.com

A Water Treatment Plant and its unique egg-shapped digesters.

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Stormwater and Combined Sewer Overflows (CSOs)

In many cities around the country – especially older cities and "Rust Belt" regions – the sewer system transports not only sewage from homes and businesses, but also stormwater. These systems are known as combined sewer systems.

When rain, sleet or snow lands on impervious surfaces, it cannot infiltrate into the ground, so it runs off into the sewer system. During certain rain storms, the sewer system and wastewater

Cross-section of a Combined Sewer System in an Urban Area

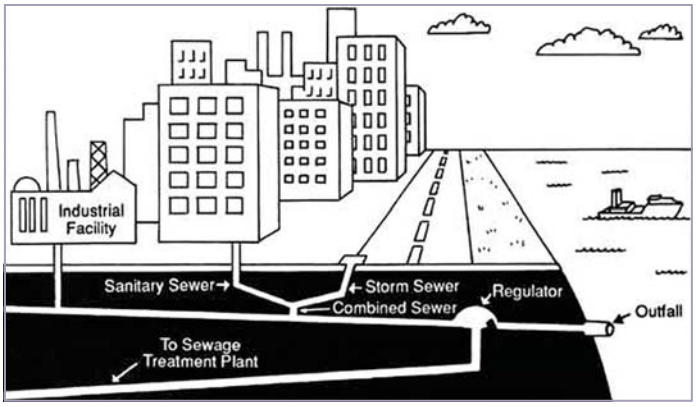

Diagram: Macaulay, CUNY.edu

treatment plants cannot handle the amount of combined sanitary and stormwater flow, so the sewer system discharges some of the combined sewage into waterways without treatment, in what is known as a "combined sewer overflow" (CSO).

Our cities and towns are paved with buildings, streets and sidewalks, and parking lots. Over the past few decades, as natural areas have been converted to suburbs, highways, and commercial strips, the amount of impervious surfaces in the United States has grown significantly, with such surfaces covering up to 94% of land in places like midtown Manhattan.[9]

Stormwater runs across these impervious areas picking up pollutants and discharging them into our sewers and waterways. Impervious areas also increase the speed at which the water runs off the surface compared to vegetated areas. This added force erodes stream banks and discharges sediments into waterways.

How can we prevent CSOs and better manage stormwater?

There are several ways to address CSOs. Large tanks can be built at the end of combined sewers (called "outfalls") that hold the wastewater until it stops raining. Once it stops raining, the wastewater is pumped to the wastewater treatment plant when it has more room to handle it. But these tanks (also called "grey infrastructure" because they are usually built of lots of concrete and other materials) are costly and can't handle all of the combined sewage.

A better option is to prevent stormwater from getting into sewers in the first place. This can be done through stormwater management technologies – also known as "green infrastructure." Green infrastructure captures or diverts stormwater from buildings, parking lots, and streets by collecting it for later use, allowing the stormwater to infiltrate the ground or using vegetation to slow the runoff process and emit water vapor through transpiration.

[9] http://blogs.ei.columbia.edu/2010/07/13/no-more-pavement-the-problem-of-impervious-surfaces/

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Photo: Blog.sustainable.org

Examples of Stormwater Management Methods

Rainwater Collection

Rainwater harvesting uses a series of gutters and pipes to channel rainwater that falls onto roof into a cistern (storage tank or rain barrel), where it can be stored for later reuse. Harvested rainwater can be used for watering plants and other purposes. In parts of the world where water is scarcer, rainwater is collected for drinking and cooking. Depending on the size, the systems can be inexpensive to install and are ideal for homeowners.

NYC Dept.Evironmental Protection

Vegetated Swales

Vegetated swales or bioswales are shallow earthen channels densely planted with vegetation that filter and convey stormwater. The plants used in swales are generally native, water resistant plants, with a high potential for removing pollutants. In addition to the plants, the layer of substrate (soil) acts as a treatments for the stormwater. These swales are often constructed in and around parking lots or along sidewalks.

ecofirms.org

Green Roofs

Green roofs are layers of plants and specially designed soils installed on the roof of a building. Green roofs are not ornamental potted plants placed on the roof, but rather an extension of the roof consisting of a membrane, drainage layers, and plants. Green roofs absorb stormwater, reducing the amount of runoff going into storm drains. Green roofs also conserve energy by insulating a building so that it stays warm in winter and cool in summer. Additionally, they improve air quality and reduce the urban heat island effect.

NYC Dept. Environmental Protection

Blue Roofs

Blue roofs collect and temporarily store rain water on the roof, and then slowly release the water into a rainwater collection system or into the drainage system.

For the Students:

Activity Worksheet:
W9a Down the Drain

Morris.Beacon.blog

Pervious Pavement

Pervious or porous pavement is a specialized type of concrete or asphalt used in the construction of flat surfaces such as streets, sidewalks and parking lots. Pervious concrete is porous, allowing rainwater to pass directly through. This allows groundwater to be recharged and also has a positive impact on trees. Pervious concrete must be regularly cleaned and maintained in order to remain porous. In the picture to the left, the right side of the parking lot is pervious pavement and the left is typical impervious pavement. Can you tell the difference?

NYC Dept. Environmental Protection

Enhanced Tree Pits

Tree pits are the small squares of soil in the sidewalk where trees are planted. In dense urban areas, tree pits are often one of the few permeable surfaces in many neighborhoods. An enhanced tree pit is a larger tree pit which has been designed to capture stormwater on a street and provide a more inviting area for the trees to grow. It contains native plants and engineered soils or gravel to retain the rainwater. The stored water may either be used by the plants or infiltrate into the ground.

Activity W9a Down the Drain

Objectives: Students will...

- Understand how water gets from a drain in their home to the wastewater treatment plant.
- Learn where their wastewater treatment plant and their combined sewer outfall are located.

Time: 1 Hour
Location: Classroom and school basement

Materials:

- Down the Drain Game Cards

Cut out the cards below. Fold each card in half and glue together. Laminate if possible.

Part One: Down the Drain Game

1. Divide the class into small groups of 4-5 students.
2. Hand out one set of cards to each group.
3. Have students put the cards in order from sink drain to the point where effluent is discharged from a wastewater treatment plant.
4. Once all groups have completed arranging the cards, review the correct order.

Correct order:

1. Toilet
2. Catch basin
3. Sewer pipe
4. Combined sewer outfall
5. Wastewater treatment plant
6. Sludge
7. Wastewater treatment plant effluent.

FOLD HERE

Photo: Usien_Wimikedia

Toilets, sinks, and showers
discharge wastewater to the sewer system.

ActivityW9a Down the Drain

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Photo: Ninoz_creativecommons

Catch basins

Catch basins direct stormwater from streets and properties to the sewer system.

Photo: mwrd.org

Sewer Pipe

A sewer pipe collects sewage from homes and businesses and conveys it to a wastewater treatment plant. Sometimes there are separate sanitary and storm sewer pipes. In a combined sewer system, the sewer conveys both sanitary sewage and stormwater.

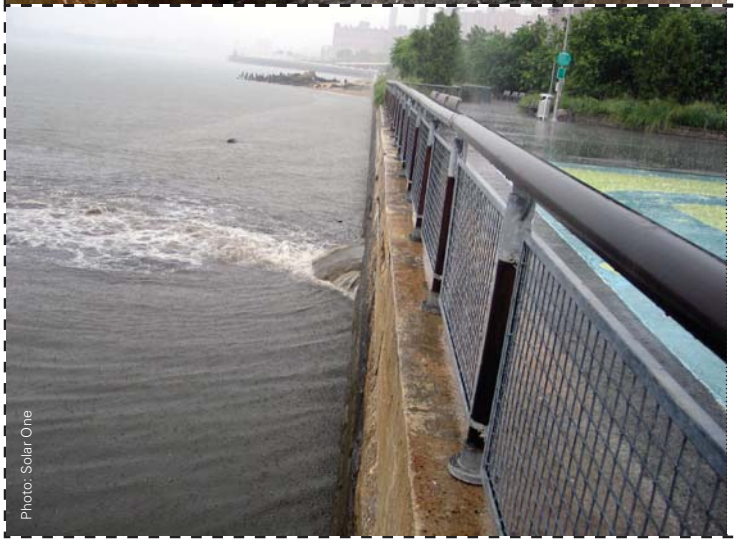

Photo: Solar One

Combined sewer outfall

In a combined sewer system, during certain rain storms, the sewer system and wastewater treatment plants cannot handle the amount of combined sewage, so the sewer system discharges some of the combined sewage into waterways without treatment, in what is known as a "combined sewer overflow" (CSO).

Activity W9a Down the Drain

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Photo: Iowa State

Wastewater Treatment Plant

Wastewater goes through treatment to remove fecal and other wastes. The sewage typically goes through primary treatment where it passes through a screen to remove trash and large objects and then into chambers and tanks where smaller particles settle out. The next step is secondary treatment where wastewater flows into large tanks filled with microbes that break down organic wastes. Through these treatment processes, wastewater treatment plants are required to remove 85% of pollutant loads.

Photo: Treehugger.com

Sludge

At the wastewater treatment plant, the solids that are collected are processed in large digester tanks (see picture of digesters in the Reader), which act as stomachs. Once digested, the resulting sludge can be put to beneficial use as fertilizer, if it meets strict contaminant levels. If not, it is typically disposed of at a landfill.

Photo: David Dixon

Wastewater treatment plant effluent

At the end of the treatment process, the water undergoes disinfection and dechlorination. Cleaned effluent is discharged into a waterbody.