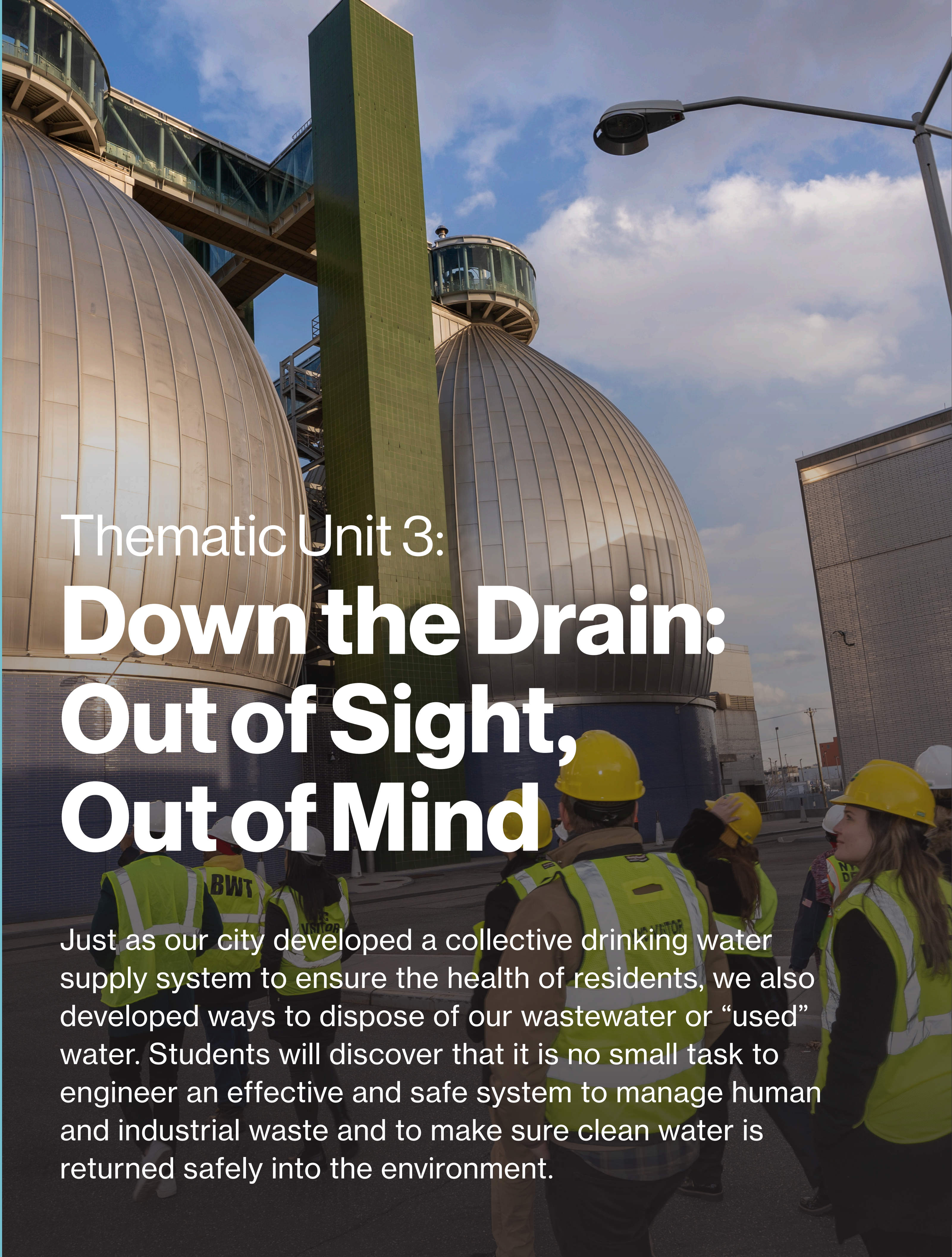

Thematic Unit 3:

Down the Drain: Out of Sight, Out of Mind

Just as our city developed a collective drinking water supply system to ensure the health of residents, we also developed ways to dispose of our wastewater or “used” water. Students will discover that it is no small task to engineer an effective and safe system to manage human and industrial waste and to make sure clean water is returned safely into the environment.

What you should know:

In many early settlements, open channels (or sewers) were constructed to help wastewater flow away from where people lived and into larger bodies of water. Flowing water became the practical receptacle for waste of all kinds.

EARLY HISTORY

The Broad Street canal, built by the early Dutch settlers in Lower Manhattan, became New York City's first open sewer. In 1676, when the canal became too polluted and the smell became too offensive, British colonists buried it underground. That is how the story of New York's sewer system began.

By the early 1800s, the city was a crowded, bustling center of commerce and culture. Waste littered the streets from horses (a common means of transportation in those days), chamber pots (before indoor plumbing), rotting trash, and putrefying entrails from butchered animals. Wastewater and rainwater often drained into open pits and canals. To deal with this growing public health problem, we began to build a haphazard network of underground pipes to divert wastewater from homes and businesses into local waterways.

As we learned in Unit 2, by the early 1830s, New York City was experiencing outbreaks of diseases such as typhoid, cholera, and yellow fever caused by unsanitary conditions and stagnant water.. This led to the creation of the Croton water system, which began supplying clean water from about 40 miles north of the city in 1842. Although drinking water quality improved, raw sewage with disease-carrying microorganisms was still being dumped into local waterways well into the 19th century, when in 1849 the city experienced one of its worst cholera outbreaks. As the city grew, so did the underground network of sewer pipes to capture and convey waste into the nearest waterway. Building an extensive underground system was just one solution to growing public health concerns. But was the problem really out of sight, out of mind?

CONTROLLING WATER POLLUTION

By the late 19th century, the discharging of untreated **wastewater** into local waterways had caused significant impacts to fisheries and tourism. There was a new understanding that in order for New York City to reduce the public health hazards brought on by increasing water pollution, it had to clean up its waste. We began by building three rudimentary wastewater treatment facilities: Coney Island (Brooklyn) in 1886, 26th Ward (Brooklyn) in 1894, and Jamaica (Queens) in 1903. All three facilities were placed in a high priority area, close to New York City's public beaches.

The management of wastewater in a city that now boasted two million people was a daunting task. These new facilities used a basic method of treatment, known today as "primary treatment." The steps were simple: 1) wastewater went through a screening process to sift out large items, 2) a sedimentation process to allow time for heavier solids to settle and lighter materials to float, 3) a disinfection process to add chlorine before returning water to the surrounding waterways. Today, about 60% of solids can be removed from wastewater through primary treatment.

Still, with the introduction of indoor plumbing and the increasing volumes of waste from manufacturing, primary treatment could not handle the pollution entering New York's waterways every day. Pollution choked aquatic life, eradicated species, and exposed human beings to disease and odors that made life in and around the waterways inhospitable. Something had to be done. By 1906, the Metropolitan Sewerage Commission was formed to evaluate the problem. They surveyed the situation and recommended improvements desperately needed to reverse the ensuing environmental catastrophe.

IMPROVING WASTEWATER TREATMENT

A more sophisticated approach to wastewater treatment was developed. We upgraded the treatment process, installed new sewers, and built additional facilities. These more advanced facilities improved upon primary treatment by mimicking the physical and biological processes that wetlands, rivers, and streams use to eliminate waste naturally.

The new or upgraded facilities included: Coney Island (1886/1935) for the waste from south and central Brooklyn; Wards Island (1937) for the western section of the Bronx and upper east side of Manhattan; Bowery Bay (1939) for the northwest section of Queens; Tallman Island (1939) for the northeast section of Queens; Jamaica (1903/1943) to collect waste from the southern section of Queens; and 26th Ward (1894/1944) to handle the Eastern section of Brooklyn near Jamaica Bay.

Today, at these facilities, **sludge**, or the heavy solids (such as food, feces, and paper fibers), is consumed by microorganisms that like to feast naturally on a diet of organic waste matter. An added boost of oxygen to create a healthy environment for these organisms helps break down the organic matter in a hurry—in hours, instead of days or weeks. This process, called secondary treatment, routinely removes more than 85% of the solids.

Between 1945 and 1965, the population grew to nearly eight million people and five new facilities were built: Hunts Point in the Bronx (1952), Port Richmond (1953) and Oakwood Beach (1956) in Staten Island, Rockaway (1952) in Queens, and Owls Head (1952) in Brooklyn. Soon after, we built our largest capacity facility, Newtown Creek (1967/2014) in Brooklyn, to handle wastewater from downtown and the east side of Manhattan, northwest Brooklyn, and a small section of nearby Queens.

ENVIRONMENTAL POLICIES

In 1972, the monumental Clean Water Act was passed, setting required minimum standards for wastewater treatment plants throughout the country. Over the next few decades, all of New York City's facilities were upgraded to meet these federal standards and ensure the removal of at least 85% of pollutants from wastewater. This included our final two facilities, North River (1986), constructed on a platform over the Hudson River in Upper Manhattan, and Red Hook (1987) in Brooklyn, which created a system of 14 facilities in total. The Clean Water Act, which we cover more in Unit 4, was a nationwide response to decades of unchecked pollution and growing public interest in the importance of environmental protection. Subsequent regulations would also play a role in how our wastewater treatment process developed over time.

Sludge collected through the treatment process is thickened and then digested in anaerobic digesters. These oxygen-free tanks are heated to approximately 98° F to help microorganisms break down organic material and eliminate pathogens. In the past, digested sludge was transported by marine boats to a site about 12 miles off the East Coast where it was disposed of in the Atlantic Ocean. By 1987, sludge disposal was extended to a deeper location more than 100 miles off the coast, but a year later, the U.S. Congress passed the Ocean Dumping Ban Act requiring that by 1992 there would be a complete ban of ocean disposal of sludge. In its place, we constructed sludge dewatering facilities at eight of the 14 treatment facilities (six of which remain in use today), and the marine boats previously used for ocean disposal were repurposed for transporting sludge to and from the dewatering facilities. **Dewatering** is the process of pumping sludge through large rotating machines called centrifuges to remove water from the sludge (like the spin cycle of a washing machine). The resulting solids are called **biosolids.**

WASTEWATER RESOURCE RECOVERY

Today, New York City's 14 **wastewater resource recovery facilities (WRRF)** recover energy, nutrients, clean water, and other resources from the wastewater treatment process. After about 8-10 hours of treatment, we remove sludge from wastewater, the water is then disinfected, and clean water is safely returned to local waterways and back into the water cycle. During sludge digestion, we recover methane gas, or **biogas**, that can be used to produce heat and electricity for the WRRFs. Once purified, it can also be distributed as renewable natural gas for the community. After sludge is digested and dewatered, the resulting biosolids can be added to agricultural soils, composted, or used in other beneficial ways.

Currently, DEP is working with other city agencies and industrial partners to recover organic solids from our waste stream. Food scraps are collected from homes, schools, and businesses and processed off-site into a nutrient-rich mixture called **bioslurry.** This material is mixed in with the sludge at DEP's Newtown Creek WRRF to help produce more biogas during sludge digestion.

Your students can see the wastewater treatment process in real-time by visiting the Newtown Creek WRRF and viewing the massive digester eggs. These stunning structures along the Brooklyn and Queens skyline are artfully designed and expertly engineered to further digest the sludge. While visiting the facility, students learn about the innovative initiatives taking place to expand opportunities for wastewater resource recovery.

NYC'S SEWER SYSTEM

None of this would be possible without the vast network of underground sewer pipes and tunnels that collects our wastewater from homes, schools, and businesses, plus the water that drains off streets, sidewalks, and rooftops when it rains, snow melts, or we water lawns or wash our cars. As population grew over the last century to nearly nine million people, so did this network of sewers.

To carry sewage quickly and effectively to these new treatment facilities, bigger pipes, called interceptors, were built to collect water that was previously drained directly to surrounding waterways. Most wastewater flows by gravity in pipes ranging from six inches to 16 feet in diameter. Pumping stations were also built in low-lying areas to help lift the wastewater to a higher elevation and allow it to continue flowing to a WRRF by gravity. Today, on average, 1.3 billion gallons of wastewater travels through 7,500 miles of sewer pipes every day. End to end that is as far as a trip to California and back!

About 60% of New York City's sewer system is a **combined sewer system**, which carries both sanitary wastewater and stormwater off the streets in the same pipe to a nearby WRRF. **Stormwater runoff** can pick up pollutants in its path, including litter, motor oil, and pet waste. Stormwater regulators are installed to prevent WRRFs from being overwhelmed during large storm events. Regulators discharge flow, called **combined sewer overflow (CSO)**, to a surrounding waterway during heavy wet weather. CSOs include a diluted mixture of untreated wastewater and stormwater runoff. We are reducing CSOs by constructing grey and green infrastructure (covered more in Units 4 and 5), and raising awareness of the importance of water conservation.

About 40% of the city's sewer system includes separate sewers. In this system, a pipe carrying only sanitary sewage is conveyed to a WRRF, while a separate pipe carries stormwater runoff directly to a local waterway through the **Municipal Separate Storm Sewer System (MS4)**. While storm sewers do not release any sewage during wet weather, polluted stormwater runoff can still impact the health of local waterways.

WATER STEWARDSHIP

Although the New York City Department of Environmental Protection (DEP) is responsible for managing and improving New York City's water systems, we all play an important role in keeping things "flowing." Did you know that pouring leftover cooking oil or grease down the drain can clog the sewers? These clogs, called **fatbergs**, consist of cooking grease, sanitary wet wipes, and other household products that are often improperly flushed down our drains. When fatbergs develop in the sewers, wastewater can back up into your homes or onto city streets. DEP's citywide Trash It. Don't Flush It. campaign encourages individuals and businesses to properly dispose of their cooking grease, wet wipes, and other household waste.

We can also help maintain the sewer system and protect harbor water quality by disposing of trash and litter properly and conserving water during wet weather. For example, DEP's WAIT program engages residents by notifying them when wet weather may lead to a CSO event in real-time, so they remember to hold off on their usual water activities to help reduce how much water flows into the sewers.

The 21st century will have new challenges, such as those brought about by climate change (covered in Unit 5). As we work to meet these challenges, you and your students can play an important role by first understanding how the system works. The environmental health of our waterways, including the harbor, wetlands, bays, beaches, rivers and creeks, play a role in the quality of life of every New Yorker, young and old, no matter where you live, work, and play.

Sequence of Lessons

1. The Growth of the City: Population and Wastewater Systems
2. Industrial Revolution and Environmental Devolution
3. Under our Noses: Creating an Underground Infrastructure
4. Sinks, Pipes, and Systems: Making the Connection
5. Wastewater Treatment Explained
6. A Healthy Harbor: Keeping Pollution at Bay

L1 The Growth of the City: Population and Wastewater Systems

In the past, water flowing into New York Harbor could be effectively filtered and cleaned by nature because pollution existed on a small scale. However, as the city's population grew, a wastewater system was needed to keep up with the daily flushing, brushing, showering, and other healthy habits of millions of busy New Yorkers. Students will discover what drives the need for an underground drainage system and how that system meets the demands of a growing population.

ESSENTIAL QUESTION

Why is wastewater treatment important?

VOCABULARY

Collect *(verb)*
To bring together into one body or place.

Drain *(noun, verb)*
An identified point to which liquid flows; to flow off gradually.

SUGGESTED IDEAS AND ACTIVITIES

a. Introduce a scenario based on the development of an early settlement from New York City's history. In the classroom, assume roles and determine how they contribute to their community's basic needs (e.g., clothing, shelter, food). Keep it simple. Designate an area of the classroom for your waste disposal. Use objects such as colorful blocks to symbolize waste that is disposed of in a nearby waterway. Discuss what it means for a waterbody to be polluted. Who and what are harmed by this pollution? Consider solutions for this scenario.

b. For older students, create the same type of scenario but build a smaller model of a fictional community or an early settlement based on the history of New York; include landforms to help simulate the downhill flow of water in open channels or creeks that drain to a nearby waterway. You can use beads, dried round peas, etc. to simulate water. Make the model inside a large breadbox so that you can prop up one side to mimic slope and gravity flow.

c. Find historic photographs of farms, mills, and factories that were formerly in your school's neighborhood using municipal and Public Library archives. Explore maps of streets and neighborhoods. Research other cities to see how they developed to find similar (or different) patterns of development.

d. Make a timeline of construction dates of NYC's 14 wastewater resource recovery facilities (shown on page 50) and map them using information found on DEP's website. Trace the outline of the drainage area where wastewater is captured by the facility nearest to your school and the waterway that receives clean water after treatment. How many million gallons of water does each facility process per day? How many people does each facility serve? Add it up and discuss.

e. List all the street names in your neighborhood or borough that are associated with water. Identify them on a historic map and research their origins. Find historic images to go with the names and write a story or poem about that place in time.

f. Watch the series, *Secrets of New York: The Sewers* to hear firsthand accounts from historians, community members, and DEP professionals. Each part of the series describes the history, process, and upgrades of the wastewater treatment process as the system developed in New York City. (Refer to DEP's Sewer System Education Module for the video and student worksheet).

g. After investigating where their wastewater is treated, have students create their own city or consider how to improve their own community, including how and where they would develop the necessary infrastructure, like wastewater treatment. After developing their plans on paper, introduce students to the online program, Visionmaker NYC, to further develop the layout of their city or community improvements.

New York City Wastewater Resource Recovery Facilities and Their Drainage Areas

CONSIDER AND DISCUSS

- Why was the development of a city close to the harbor so important for early settlers? Consider all of the benefits for communities close to water (transportation, energy, food, trade, waste disposal, etc.).
- What do you think New York City and the surrounding waterways were like during the early industrial age, before we began managing wastewater?
- How does building and maintaining a water or wastewater system, including underground pipes, affect communities?

ASK THE EXPERT

City Archivist – a professional who assesses, preserves, and catalogues artifacts, documents, photographs, maps, and more, from the past.

L2 Industrial Revolution and Environmental Devolution

The way we use land impacts water quality. Farms, factories, stores, homes, and transportation systems are all examples of how we change the natural landscape to meet human needs. New York City's growth in the 19th century did not happen without consequences for the natural environment—wetlands were filled in, waterways became polluted, and roadways were built. Fortunately, before we caused even more irreparable harm, we began tipping the balance the other way; but no one will deny, it continues to be a delicate balance.

ESSENTIAL QUESTION

How does human activity impact water quality?

VOCABULARY

Industrialization *(noun)*
The large-scale development of manufacturing, advanced technical enterprises, and other productive economic activity in an area, society, or country.

SUGGESTED IDEAS AND ACTIVITIES

a. Take a walking tour of your neighborhood. Take photographs, make observations, and map out places of interest in relation to where your school is located. Document such things as the different types of buildings and new construction, public transportation (subways, buses, and ferries), parks and green spaces. How might these places or activities impact water quality in nearby waterways?

b. Start a conversation about the different ways people use land to live, work, and play. Have students discuss what an ideal community might need. Plan and design your own communities. Use a large sheet of mural paper and a handful of pre-cut color-coded squares, which represent different kinds of land uses (e.g., places we live - red, places we work - purple, and places we play - green). Start with an outline of a surrounding waterway and a few roads. Discuss placement of land use and potential sources of pollution from the community that could impact the waterway.

c. Make the previous activity more complex by introducing more land use parameters such as agrarian land, industrial land, and dense city. Introduce the themes of controversy and choice. Explore different time periods in New York City's history and create a chronology of common polluters of water through time.

d. Add to the above activities by discussing zoning. Divide the class into neighborhood or community groups with connecting waterways. Discuss the impact of different actions on adjacent neighborhoods. Research famous city planners and the legacies (both good and bad) they left on city neighborhoods, including Robert Moses. Encourage some students to research the community advocates who often fought to protect their neighborhoods from large-scale changes (e.g., Jane Jacobs).

e. Visit a shoreline green space or park, such as the Newtown Creek Nature Walk (use the online scavenger hunt guide), to observe aspects of New York City's industrial history, water pollution, and present-day changes to improve community spaces.

f. Visit the Brooklyn Navy Yard and tour Building 92 to see New York City's story of industrial shipping and development come to life. How have uses of the Navy Yard evolved over time?

CONSIDER AND DISCUSS

- Discuss the balance (and imbalance) between growth and health of cities and the impacts on the natural environment. Consider the impacts due to vertical development, suburban sprawl, and expansion in search of natural resources, in New York City, throughout watershed communities, and other large cities around the world.
- What kinds of waste do different industries generate? Which industries are commonly found in New York City (past and present)?
- Define sustainability. Explore and discuss how a city can be more sustainable and what it means for our future.

ASK THE EXPERT

City Planner – a professional who designs urban spaces and plans urban land usage.

L3 Under our Noses: Creating an Underground Infrastructure

There are nearly 7,500 miles of sewer pipes below New York City streets and buildings. Not everything is hidden; from the curve of the street to the catch basins at each corner, you can watch as water drains away. In New York City, combined sewers make up about 60% of the underground system, collecting both wastewater and stormwater in one pipe and transporting it to a nearby wastewater resource recovery facility. About 40% of our sewer system is separated, and includes a sanitary sewer pipe that conveys wastewater directly to a facility, and a storm sewer that drains stormwater runoff to the nearest creek, river, or bay.

ESSENTIAL QUESTION

How does infrastructure help a city develop?

VOCABULARY

Infrastructure *(noun)*
The underlying foundation or basic framework of public works which provide services that are essential to facilitate the operations of a city, state, country, or region.

SUGGESTED IDEAS AND ACTIVITIES

a. How have you used water today? Discuss with students what goes down their drains with their wastewater and where they think it goes. Share images of the various components of the wastewater treatment system and help students begin to understand the important interconnections, including how they play a role in reducing litter on our streets and conserving water (especially when it rains!). (Refer to DEP's Navigating New York City's Wastewater Treatment System lesson).

b. Begin exploring underground systems through fictional characters in books or movies that live or travel by sewer. Have students create a character that lives in a similar setting. Write a comic strip, picture book, or narrative story about this character. The character can even be an object (such as a bag of chips) that goes down a catch basin and meets up with someone's soap bubbles from the shower drain.

c. Research and compare other examples of urban infrastructure ("works") such as electricity, gas, and transportation as well as the idea of public/private management of these systems locally and in other cities. Make a photo-montage or inventory of the evidence of these systems in schools and around our neighborhoods.

d. Ask your students if they can identify catch basins or sewer covers along the street. Take photographs on the route to school to share. If the catch basin is clogged, what can they do to help? Do the sewer covers have a design/pattern? What information can we gather from what's engraved on top? Challenge students to redesign catch basins and sewer covers, including important messages about what happens below our feet. Consider what issues may influence a new design (litter, flooding, etc.).

e. Look at New York City sewer system maps to understand what type of drainage system is found in your neighborhood. What are the impacts of having this system? Compare what happens during wet weather and on a dry day. How can we be good stewards of this system?

f. Study historical cities and how water infrastructure was created. Build a diorama, write an essay, and/or draw a map of the different water infrastructure and management techniques (e.g., Ancient Rome, Khmer Empire).

CONSIDER AND DISCUSS

- How did ancient cities like Rome design infrastructure to deal with drainage? How did the advent of sewers help people and cities develop?
- Explore DEP's Sewer System Virtual Tour for video interviews, maps, and more activities. What do you think we would find inside the sewers? What are the sources of this waste?
- What are the advantages and disadvantages of the different types of sewer systems (combined and separate)? What other systems could be designed to collect and treat wastewater and stormwater?
- How might changes in rainfall, rising sea level, or other impacts of climate change affect New York City's wastewater system?

ASK THE EXPERT

Engineering Researcher – a professional who researches and models different engineering methods.


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L4 Sinks, Pipes, and Systems: Making the Connection

There are many component parts of the underground sewers that are molded, manufactured, and engineered to create our urban system. They fit together to keep our wastewater flowing, relying mostly on gravity to keep everything moving "downhill." Sewers are built in a variety of shapes (or profiles), including rectangular, circular, and elliptical. Although at first sewers were built with brick, clay, or cement, they are now built of reinforced concrete or vitrified clay, materials that withstand corrosion.

Some materials that go down our drains can cause real damage to the system. Cooking grease, sanitary wet wipes, and other household products are the primary cause of fatbergs, or clogs that lead to back-ups in the system. Help students understand what goes down our drains is not simply *out of sight, out of mind*.

ESSENTIAL QUESTION

Where does your used water go after it flows down your drain?

VOCABULARY

Conduit (*noun*)
A closed channel or pipe used to convey water or another fluid.

SUGGESTED IDEAS AND ACTIVITIES

a. Find objects in everyday life that can be used to demonstrate how a conduit works (e.g., bendable or straight straws, paper towel rolls), add beads to show the flow of water by gravity.

b. Make a kit of different parts using various diameter tubing, shapes, and forms to create conduits that can convey water. Test the velocity using a variety of flow and slopes.

c. Create individual homes on a street by re-using shoeboxes. Configure them to create the sidewalk and street. Elevate the model to create some space under the street. Use blue (drinking water) and red (wastewater) pipe cleaners to represent the path of water coming in from a pipe underground and the waste leaving through a separate pipe. Connect the pipes from each home underground to each other. Investigate why pipes in a sewer system have names like *main, trunk, branch,* and *interceptor*.

d. Introduce the concept of fatbergs to your students. Research the proper ways to dispose of waste at home (Hint: only flush the 4 Ps -- poop, pee, puke, and toilet paper!). Have your students create and conduct a survey for their families to record the types of waste that go down their drains. List out all of the things that have clogged our pipes at home before (e.g., hair, grease, food scraps). Discuss the proper ways to dispose of waste products at home.

e. Research news articles on water and sewer operations, checking for stories of main breaks, fatbergs, or construction of new sewers in your neighborhood. What are the impacts to your neighborhood? Create public service announcements (PSAs) to share information with classmates, family members, and neighbors; for example, explain what causes sewer back-ups and what we can do to help prevent fatbergs from clogging the sewer system.

CONSIDER AND DISCUSS

- How is our sewer system constructed today? How are sewers inspected and maintained?
- Consider how the sewers co-exist with other utilities and roads, and what we can do to help such infrastructure function properly.
- How have fatbergs impacted New York City? How have other major cities prevented fatbergs and managed their sewer systems?

ASK THE EXPERT

Sewer Inspector – a professional who performs inspection work in connection with the construction, maintenance, and operation of sewer systems.

L5 Wastewater Treatment Explained

Wastewater treatment is the process of collecting wastewater, removing contaminants, and returning clean water to the environment. It is an important and sophisticated process that runs 24/7 without much notice or fanfare. Everything washed down a drain is collected--from toilets, sinks, tubs, washing machines, and dishwashers in homes, schools, and businesses every day. In New York City, stormwater runoff collected from streets and sidewalks typically combines with this wastewater to travel to a nearby facility. This process ensures our own health and the protection of our waterways.

ESSENTIAL QUESTION

How does the wastewater treatment process mimic nature?

VOCABULARY

Biogas *(noun)*
The methane gas recovered from sludge digestion that can be used as renewable natural gas.

Biosolids *(noun)*
The solid by-products recovered from the wastewater treatment process that can be used beneficially.

Sludge *(noun)*
The solids, such as food, feces, and paper fibers, in wastewater that are settled out and removed during the wastewater treatment process.

WASTEWATER TREATMENT PROCESS

At New York City's 14 wastewater resource recovery facilities (WRRFs), wastewater undergoes several processes to remove pollutants before clean water is safely released to local waterways (shown on page 57). These physical, chemical, and biological steps closely mimic how wetlands, rivers, streams, and lakes naturally cleanse water (but at a much faster rate!).

- **Preliminary Treatment –** Wastewater enters a facility and passes through bar screens to remove leaves, twigs, and litter such as plastic bags, bottles, and sanitary wet wipes. Main sewage pumps then pump wastewater up from the screens to the surface level of the facility.
- **Primary Treatment –** Lighter solid material, such as grease and small plastic particles, is skimmed off the top of primary settling tanks, while gravity helps heavier solids sink to the bottom. Heavier solids, called sludge, are removed for thickening and digestion.
- **Secondary Treatment -** Wastewater then goes through aeration and final settling. During aeration, air is added to foster a healthy environment for oxygen-loving micro-organisms. These helpful microorganisms consume the organic material in wastewater and, as they become "full", settle to the bottom of final settling tanks. Most of this activated sludge is removed and combined with primary sludge for thickening and digestion, while some is returned to the aeration tanks to help process incoming wastewater.
- **Disinfection -** Sodium hypochlorite (the same chemical found in household bleach) is added to remove any remaining disease-causing microorganisms. Clean water is then released to a nearby waterway.
- **Sludge Digestion -** Thickened sludge is digested by micro-organisms that thrive in a low-oxygen environment heated to about 98°F. Methane gas, or biogas, released during digestion can be used to produce heat and electricity for the facility and also purified and distributed as natural gas for the community. Treated sludge is then dewatered, or spun to remove water from the solids. The resulting biosolids can be composted, added to agricultural soils, or further processed for other beneficial uses.

SUGGESTED IDEAS AND ACTIVITIES

a. Discuss the idea that people make this process work! Have students learn about various jobs within our wastewater treatment system. See this process come to life at DEP's Visitor Center at Newtown Creek, located at the Newtown Creek WRRF, and learn more about the people, science, and technology behind wastewater treatment.

b. Review your previous activities related to the journey of your flush down the toilet and have each student add to the story to create a suspenseful narrative from the perspective of something you flush, what it feels like to be in a sewer, and what happens when you arrive at a WRRF. Next, make a storyboard book or illustration to share with classmates.

c. To help demonstrate the primary wastewater treatment process, fill up a container with water and add pieces of toilet paper, dirt, small rocks, food scraps, and cooking oil. Shake it up. Pour your mixture through a strainer into a second container. Make sure you include things that will sink, float, and stay suspended. Have your students experiment and document observations. (Refer to DEP's Wastewater Treatment lesson).

d. In small groups, act out the steps of the wastewater treatment process. What motions or gestures can you use to depict the process? Review the steps and consider the different types of science used – physical, biological, and chemical. Consider how the process mimics nature and our own bodies (sludge digestion is similar to your stomach's digestion!).

e. Research how wastewater is treated in other countries. How does the treatment process differ? Connect this research to current events related to severe weather events that may shut down or flood facilities due to storm surge, energy loss, or other issues. Compare and contrast with New York City.

f. Create a poster display of animals and plants that act as natural filters (Hint: bivalves, cattails). How much water are they able to filter in a day? How are these species an important part of our water history? Which ecosystems do they inhabit?

g. Relate this treatment process back to your school. The Newtown Creek WRRF receives food scraps from homes, schools, and businesses, which are processed into a nutrient-rich bioslurry and mixed with sludge during digestion to help produce more biogas. Discuss the importance of properly sorting food scraps in your school cafeteria. Educate classmates about this food waste-to-energy initiative with posters or videos.

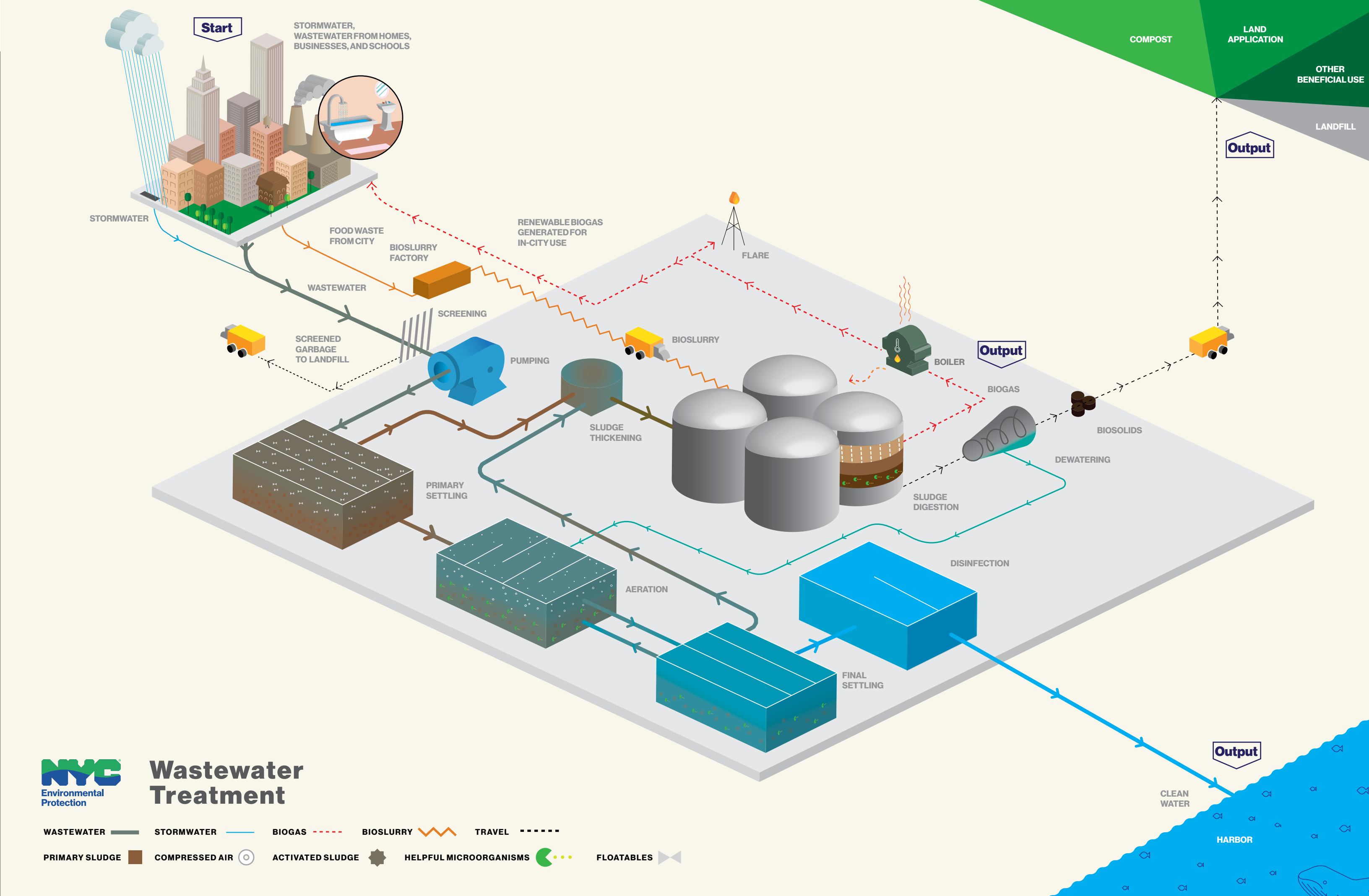
h. Following a trip to the Visitor Center at Newtown Creek, consider the history of why and how New York City's facilities were upgraded. Research a specific challenge to the wastewater treatment process in current events (Hint: sanitary wet wipes, trash, or micro-plastics; or climate change and natural disasters). Discuss solutions, including the benefits of reducing waste, as well as recycling and reusing materials. What are some examples?

CONSIDER AND DISCUSS

- Discuss the history of wastewater treatment in New York City. How has the treatment process advanced over time and why was it necessary?
- Explore DEP's Wastewater Treatment Virtual Tour for video interviews, maps, and more activities on the wastewater resource recovery process. Discuss changes students can personally make to help improve the process and overall water quality (e.g., organic cleaners, picking up after their dog, not littering).
- Learn about DEP's WAIT Program for community members who voluntarily choose to wait before using water during heavy storms. How can water conservation help New York City manage wastewater and protect our harbor water quality?

ASK THE EXPERT

Sewage Treatment Worker – a professional who operates and maintains machinery, equipment and structures for the wastewater treatment process at wastewater resource recovery facilities.


Start
STORMWATER, WASTEWATER FROM HOMES, BUSINESSES, AND SCHOOLS
STORMWATER
FOOD WASTE FROM CITY
BIOSLURRY FACTORY
RENEWABLE BIOGAS GENERATED FOR IN-CITY USE
FLARE
WASTEWATER
SCREENING
SCREENED GARBAGE TO LANDFILL
PUMPING
BIOSLURRY
BOILER
Output
BIOGAS
BIOSOLIDS
SLUDGE THICKENING
DEWATERING
PRIMARY SETTLING
SLUDGE DIGESTION
DISINFECTION
AERATION
FINAL SETTLING
COMPOST
LAND APPLICATION
OTHER BENEFICIAL USE
LANDFILL
Output
Output
CLEAN WATER
HARBOR
NYC Environmental Protection
Wastewater Treatment
WASTEWATER
STORMWATER
BIOGAS
BIOSLURRY
TRAVEL
PRIMARY SLUDGE
COMPRESSED AIR
ACTIVATED SLUDGE
HELPFUL MICROORGANISMS
FLOATABLES


VISITOR
NYC VISITOR

L6 A Healthy Harbor: Keeping Pollution at Bay

For nearly a century, human and industrial waste was discharged untreated into our once-pristine waters. The odors, the filth, the bacteria festering in the creeks, streams, and bays posed a threat to our public health and also to the health of the ecosystem. The construction of wastewater resource recovery facilities along with significant policy changes, have contributed to the water quality improvements that have seen an increase in recreational boating and resurgence of marine life, including increasingly frequent sightings of whales and dolphins. Treated water from all 14 wastewater resource recovery facilities is tested before it is discharged into local waterways. We began monitoring the health of New York Harbor more than 100 years ago, and today, DEP continues to sample and test water quality from more than 70 locations citywide.

ASK THE QUESTION

How do we determine the health of the harbor?

VOCABULARY

Water Quality *(noun)*
The biological, chemical, and physical conditions of a body of water; a measure of a waterway's ability to support aquatic life and beneficial uses.

SUGGESTED IDEAS AND ACTIVITIES

a. Collect historical postcards from Coney Island and other beaches in and around New York City and create an exhibit in the classroom. Add photographs from present day. Create and compare works of art of the same theme.

b. Make a model, diorama, or classroom size drawing of a busy harbor filled with various types of boats (e.g., cruise ships, tug boats, sailboats, ferries, freighters). Add piers and landings, buoys, boardwalks, and warehouses. Discuss what a harbor is, what role these boats play in the life of New Yorkers, and how pollution could impact these activities.

c. Take a field trip by boat! Travel to Ellis Island and the Statue of Liberty to celebrate New York Harbor as a symbol of liberty and freedom in America. Plan a trip with a local organization that showcases the history of boating and the harbor, such as South Street Seaport Museum or Hudson River Sloop Clearwater. Or visit another location (like Brooklyn Bridge Park) and travel by New York City Ferry, New York Water Taxi, or Staten Island Ferry. Make observations from the water about different land uses seen along shorelines.

d. Visit the Jamaica Bay Wildlife Refuge at Gateway National Park in Queens. Take a walk with a park ranger to explore the many species of plant life, waterfowl, and other wildlife inhabiting the historic area. Keep observations and illustrations in a field journal. Refer to the Jamaica Bay Education Resource Directory for additional ideas.

e. Introduce students to harbor water quality testing. Over the course of the year, collect water samples from a nearby waterway to measure water temperature, pH, dissolved oxygen, salinity, turbidity, and more. Compare results to data from DEP's Harbor Survey Program, plot and graph results, and analyze data trends and fluctuations throughout the year.

f. Research and present a report about the life of various notable leaders in New York City's sewage history like Dr. George Soper, who led the Metropolitan Sewerage Commission in the early 1900s, or Richard H. Gould, a sanitary engineer who evaluated survey data in the early 20th century. Find other sanitary, chemical, or civil engineers of note.

g. As a class, participate in the annual, "A Day in the Life of the Hudson River & Harbor" event, hosted by New York State Department of Environmental Conservation and Lamont-Doherty Earth Observatory. Collect water samples and compile data on the conditions of the river ecosystem as citizen scientists.

h. Explore and explain the history of the shellfish industry and current efforts to restore them to the waterways. Team up with educators from Billion Oyster Project to hear how the organization is working with citizen scientists (like you!) to restore healthy oyster habitat and populations around New York Harbor.

CONSIDER AND DISCUSS

- Consider how important the scientific data from water quality monitoring was, and continues to be, for informing the decisions engineers make about maintaining and improving the wastewater treatment system.
- Discuss what changes students can personally make to help improve water quality in New York's waterways and why protecting waterways is important.
- Explore DEP's Harbor Water Quality Virtual Tour for video interviews, maps, and more activities on water quality monitoring and stewardship. Connect the concepts of harbor water quality with previous topics, including combined and separate sewer systems, and Combined Sewer Overflow (CSO).

ASK THE EXPERT

Marine Biologist – a scientist that studies organisms that live in saltwater.