Water Quality

In this Unit:

This Unit has been modified by permission by the Newtown Creek Alliance from the original with assistance from the National Wildlife Federation's Greenpoint Eco-Schools Program. The original module was developed by the Gowanus Canal Conservancy.

Unit Overview

Essential Questions:

- What are some indicators of a healthy aquatic ecosystem?
- How is water important to life?
- How can we effectively test the water quality of Newtown Creek?
- What can water quality testing tell us about the health of Newtown Creek?
- What are the ecosystem benefits of improving the water quality in Newtown Creek?
- What is the function of water quality within the greater sewershed?
- How has water quality of Newtown Creek changed over time?

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Teacher’s Introduction

What is Water Quality?

Water quality refers to the conditions of water. Water can include chemical, physical and biological characteristics, usually with respect to the needs of one or more biotic species, including humans, plants and animals.

Why Teach Water Quality Testing in Newtown Creek?

Water quality testing provides a window into the health and vitality of Newtown Creek. It can:

- Help to identify specific pollutants and sources of pollution
- Determine whether the waterbody is meeting standards for specific uses, such as recreation or fishing
- Monitor and analyze trends over time
- Monitor impacts of disturbances, such as flooding or a chemical spills

Water quality testing provides a strong basis for inquiry. For example, how does salinity, temperature and dissolved oxygen change as the tide rises and recedes, and what might this information tell us about the flushing action of the tides? Do runoff and combined sewer overflow events have an impact on Newtown Creek? If so, what is that impact and how can it be measured? Do different testing locations along the Creek reveal different results (e.g. near an outfall, near the Mouth of the Creek, in the far tributaries, or in the Turning Basin)?

When testing, students will see a “snapshot” of the water quality in Newtown Creek. It should be noted that the most interesting and meaningful water quality data sets emerge when the Creek is tested over time. Such long-term monitoring reveals the trend over days, months, seasons, and years. It could also uncover the presence of currently unknown sources of pollution.

Water quality testing involves using the steps of the **Scientific Method** and always includes following safety procedures.

- **Making observations**
- **Forming a hypothesis**
- **Testing that hypothesis using an experiment**
- **Taking measurements and the importance of accuracy**
- **Data collection and recording**
- **Comparison of data**
- **Analysis and interpretation of data to draw conclusions**
- **Communicating results**

Visible pollution on Newtown Creek (Source: Newtown Creek Alliance)

Newtown Creek Water Quality Background

Newtown Creek is one of the most polluted bodies of water in the U.S. and an important place in which to monitor water quality. It is a relatively stagnant body of water, especially in the back tributaries or headwaters, that has remained intensely polluted for more than 150 years from industrial waste, untreated sewage discharges and storm water runoff.

From the beginning of European settlement in the late seventeenth century until the latter part of the 20th Century, industries along the Creek had free reign over the disposal of unwanted byproducts. Industry decided what and how waste products were dealt with and much of it went directly into the creek itself. With little-to-no government regulation or knowledge of the impact on human health and the environment, it was often easier and cheaper to discard waste in and around the Creek The legacy of this abuse has left local scars and environmental burdens including the infamous Greenpoint Oil Spill, a 17 to 30 million gallon underground plume of oil caused by Standard Oil and its progeny companies. While much of the historic pollution is being cleaned up, these contaminants, along with the dumping of old tires, cars and everyday plastics still have a negative impact on the water quality in the Creek.

Oil sheens on surface waters are common sights in many areas of the Creek.
(Source: Newtown Creek Alliance)

Combined Sewer Overflows (CSO) are a major source of pollution in the Creek, past and present. CSOs are triggered during wet weather events; either snow or rain, when stormwater runs off the streets and other impermeable surfaces into the sewer system via catch basin. That stormwater combines with the sanitary sewage coming from our toilets, showers and sinks and then heads to a local wastewater treatment plant. Unfortunately, these plants can only clean so much wastewater and once they hit capacity during rain events, the combined sewage backs up and is discharged directly into local waterways through outfall pipes. In some instances, as little as 1/10th and inch of rain can overwhelm the system and cause CSO.

Every public waterway in NYC is impacted by CSOs. Included in CSOs are oils and chemicals that wash off the streets such as road salt, gasoline, trash and dog waste. Additional pollutants come from sanitary sewers, such as human feces, harsh household and industrial cleaning chemicals, personal care products, and pharmaceuticals. The contaminants in CSOs cause excessive nutrient levels in the waterways which trigger algae population explosions resulting in decreased oxygen levels. This combination poses risk to human health, is detrimental to habitat conditions and dangerous for the health of marine life. CSOs can create cloudy or turbid water, preventing sunlight from passing through to the marine plants below. This prevents sunlight dependant plants from performing photosynthesis, plants cannot survive for very long in turbid waters. Polluted sediment can build up on the bottom of the stream and river floors, which damages benthic habitats (ecological zone at the lowest level of a water body), especially in waters that don't experience much natural mixing or flow.

An active combined sewer outfall in a Newtown Creek tributary. (Source: Newtown Creek Alliance)

Improvements to Newtown Creek Water Quality

Below is a brief overview of the history of water quality standards to highlight the importance of having state and federal regulations. The 1972 Clean Water Act [1] created a set of water quality standards which must be implemented by the New York State Department of Environmental Conservation (DEC) and New York City Department of Protection (DEP), these both are overseen by the Environmental Protection Agency (EPA), all of these entities are government regulatory agencies. These are the primary

[1] Summary of the Clean Water Act https://www.epa.gov/laws-regulations/summary-clean-water-act

agencies that are responsible for improving water quality in Newtown Creek and in the surrounding harbor.

In order to comply with the federal Clean Water Act DEP has developed a Long Term Control Plan[2] (LTCP) to improve water quality in the Creek. The Newtown Creek LTCP is a set of proposed infrastructure upgrades which would reduce the approximate 1.2 billion gallons of CSO entering the Creek each year.

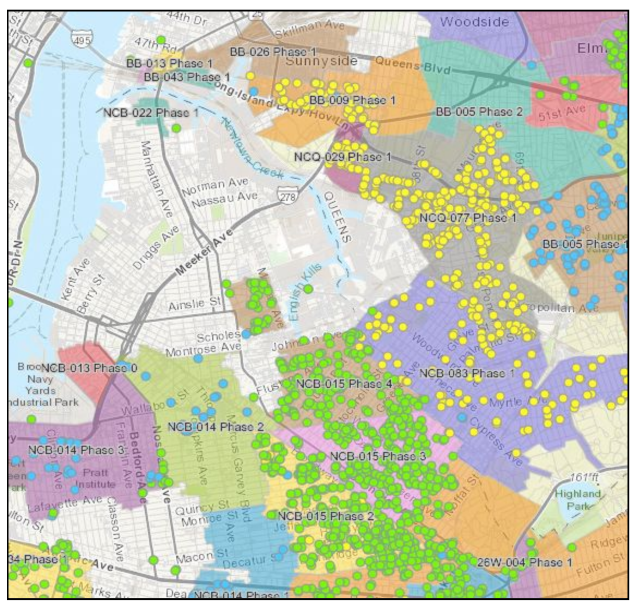
The plan will reduce pathogen levels, as well as odors and marine debris, while also improving dissolved oxygen levels. The main component of the proposed LTCP is a massive *39 million gallon underground tunnel* that will collect over 60% of annual CSO discharges from the 3 largest outfalls on Newtown Creek. The tunnel is scheduled for completion by 2042 which means the significant impacts of ongoing CSOs, including the severe ecological stresses and threats to human health. CSO's will continue to impact the surrounding communities for at least the next 25 years.

Map of the proposed LTCP retention tunnel. Source: DEP

[2] Newtown Creek CSO LTCP
http://www.nyc.gov/html/dep/pdf/cso_long_term_control_plan/ltcp-newtown-creek-cso.pdf

A typical Right of Way (ROW) Rain Garden captures stormwater as it flows down city streets. They are often planted with native plants that are chosen for tolerance for extreme conditions like flooding and drought, salt, metals and other traits that make them more likely to withstand the harsh conditions on the street. Even with these careful selections, rain gardens need care in order to thrive. (Source: Waterfront Alliance)

This map shows the expansion of DEP's *Right of Way Rain Garden*[3] program. This Green Infrastructure expansion is critical to capturing stormwater before it makes its way into the sewer system. Green dots are completed Rain Gardens, blue dots are under construction (as of 2018) and yellow dots are those that are in design. (Source: DEP)



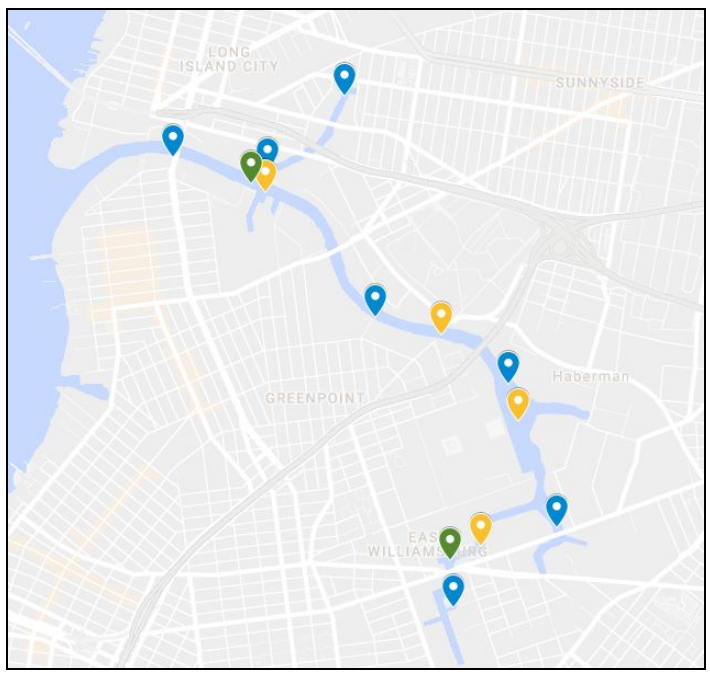
[3] US EPA Newtown Creek Superfund
https://cumulis.epa.gov/supercpad/SiteProfiles/index.cfm?fuseaction=second.topics&id=0206282

Water Quality Testing in Newtown Creek

Improving water quality is key to the revitalization of Newtown Creek. Through our water quality monitoring programs we track bacteria and oxygen levels at various Creek locations, while also analyzing factors like rainfall and temperature to understand where water quality varies and why.

In 2016 the Newtown Creek Alliance published *Newtown Creek SAMPLES* an intensive six month water quality monitoring program in collaboration with the Environmental Science department at LaGuardia Community College. The project tested for enterococcus (a sewage related bacteria), dissolved oxygen, salinity as well as nitrogen and phosphate levels at eight different locations.

The project booklet summarizes a number of key findings from the sampling program, as well as information about what impairs water quality and how community members can help improve conditions. The 2017 Report was released in early 2018, testing continues through the 2018 season and funding has been secured for ongoing monitoring in the 2019 season. A number of organizations and agencies conduct water quality testing in the Creek, including NYCDEP, contractors working for the EPA, and water advocacy organizations Riverkeeper and Newtown Creek Alliance.



Newtown Creek Water Quality Sampling Sites: NYCDEP (Yellow), NCA (Blue) and Riverkeeper (Green).

The New York State Department of Environmental Conservation uses two metrics - dissolved oxygen (DO) and fecal coliform bacteria - as indicators of ecosystem health and degradation. State standards reflect a range of acceptable water quality conditions corresponding to state designated “best usage” of the water body. In addition, the Environmental Protection Agency (EPA) recommends a standard for enterococci in marine recreational waters (see table below). All the efforts to improve water quality in Newtown Creek and around the City reflect the need to meet these federal and state standards. They have been developed to protect life and human health. Without these regulatory standards who knows how bad our water would be!

EPA Water Quality Standards			
Best Usage	**Dissolved Oxygen** *(Never less than…)*	**Fecal Coliform**[(a)] *(Less than…)*	**Enterococci Bacteria**[(a)] *(Less than…)*
Bathing/Recreation	5.0 mg/L	200 cells/100 mL	35 cell/100 mL
Fishing/Boating	4.0 mg/L	2,000 cell/100 mL	No Standard
Fish Survival	3.0 mg/L	No Standard	No Standard
Note: (a) geometric Mean			

Source: http://www.nyc.gov/html/dep/pdf/hwqs2012.pdf

Determining the water quality of Newtown Creek requires completing a battery of tests. There are over a dozen different tests that are regularly used by organizations and agencies that monitor water quality.

This unit will focus on the four of the seven of the most fundamental water quality tests:

1. **Temperature**
2. **Salinity**
3. **Dissolved Oxygen**
4. **pH**
5. Turbidity
6. Nitrates
7. Fecal Coliform

Temperature Background

No doubt you already have a good idea of what temperature is. You probably define it as how hot or cold something feels. In physics, temperature is defined as the average kinetic energy of the particles in an object. When particles move more quickly, temperature is higher and an object feels warmer. When particles move more slowly, temperature is lower and an object feels cooler.

Temperature is measured with a thermometer. A thermometer shows how hot or cold something is relative to two temperatures; the freezing and boiling points of water. Scientists often use the Celsius scale for temperature. On this scale, the freezing point of water is 0°C and the boiling point is 100°C.

Look at the thermometer below. Particles of the red liquid have greater energy when they are warmer, so they move more and spread apart. This causes the liquid to expand and rise higher in the glass tube. Like the liquid in a thermometer, most types of matter expand to some degree when they get warmer.

Something that has a high temperature is said to be hot. Does temperature measure heat? Not really. Heat is the transfer of thermal energy between objects that have different temperatures. Thermal energy always moves from an object with a higher temperature to an object with a lower temperature. When thermal energy is transferred in this way, the warm object becomes cooler and the cool object becomes warmer. Sooner or later, both objects will have the same temperature. Only then is the transfer of thermal energy complete. Picture a spoon and a cup of hot chocolate. The spoon is cool to the touch. When you put the spoon in the hot chocolate the thermal energy begins to transfer from the hot chocolate to the spoon. The spoon quickly gets warmer and the hot chocolate gets a bit cooler until they are the same temperature.

Specific heat is the amount of energy needed to raise the temperature of 1 gram of a substance by 1°C. Metals such as iron have relatively low specific heat. It doesn't take much energy to raise their temperature. That's why a metal spoon heats up quickly when placed in hot chocolate. Sand also has a relatively low specific heat, whereas water has a very high specific heat. It takes a lot more energy to increase the temperature of water than sand. This explains why the sand on a beach gets hot while the water stays cool. It takes all winter for the estuary to cool down and all summer for the estuary to warm up because water has a high specific heat.

Text Source: https://www.ck12.org/c/physical-science/

Salinity Background

Most of the salt in the oceans has come from rain falling on the land and dissolving the salts in eroding rocks. These salts are carried down the rivers and out to sea. The salts accumulate in the ocean as water evaporates to form clouds. This process has been going on for millions of years and progresses very slowly. The oceans are getting saltier every day, but the rate of increase is so slow that it is virtually immeasurable. Ocean water is currently about 3.5 percent salt (or 35 parts per thousand).

There are many different instruments and methods for measuring salinity. You will use a less expensive, but fairly accurate hydrometer in this unit. This hydrometer is influenced by density.

The density of something has to do with its mass (usually expressed in grams) relative to the amount of space it takes up (volume). At a temperature of 3 degrees Celsius, a glass of fresh water has a density of 1 gram per cubic centimeter (1g/cm3). For example, a quart of one particular type of oil has a larger mass than a quart of water. Therefore, the oil is denser than the water. Similarly, as water becomes saltier, its mass increases relative to its volume, making it more dense.

Salinity is measured in parts per thousand (ppt). What does that mean? If you have a total of 1000 gumballs, and 999 of them are white, and one of them is black, the black gumball could be expressed as 1 part per 1000. Let's say you use the hydrometer and it gives you a measurement of 20 ppt. That means for every 1000 molecules, 20 of them are salt molecules and 980 of them are water molecules.

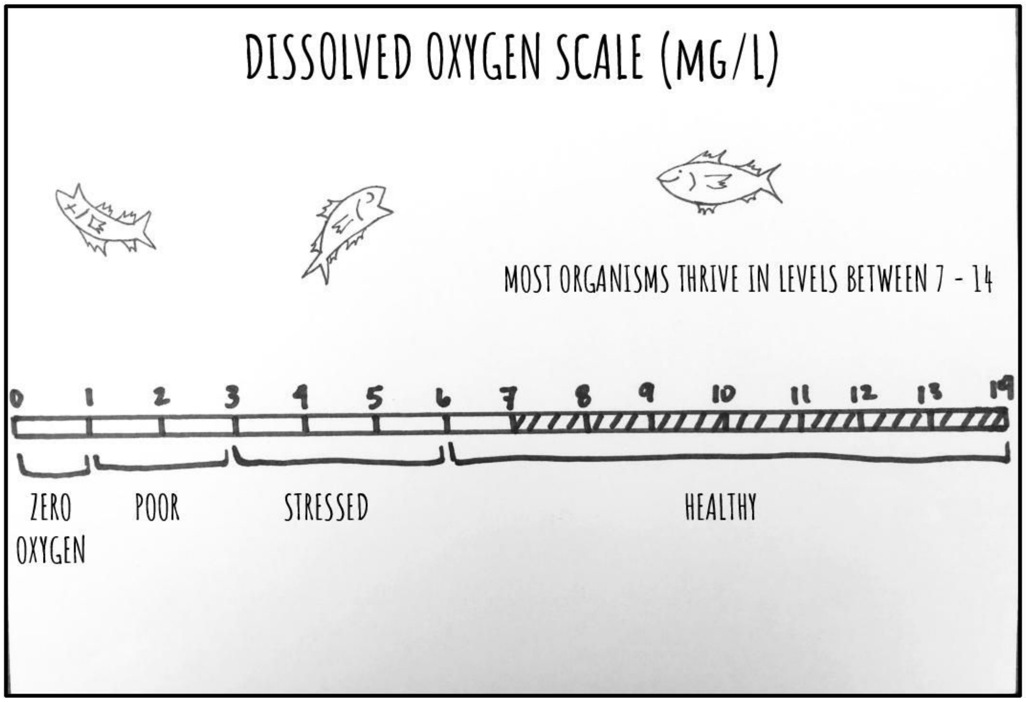
When the hydrometer is placed in the water, it will float to a certain level, depending on how dense the water is. The extra minerals, or salts, in saltwater make the water more dense, which means it can support more weight than water lacking those salts. This makes the hydrometer arm float higher as the water gets saltier.

Text Source:
http://mddnr.chesapeakebay.net/eyesonthebay/lesson_plans/salinity_lesson_plan.pdf

Dissolved Oxygen in a Tidal Estuary Background

To survive, fish, crabs, oysters and other aquatic animals must have sufficient levels of dissolved oxygen (DO) in the water. The amount of dissolved oxygen in an estuary's water is a major factor that contributes to the type and abundance of organisms that can live there. Aquatic organisms such as zooplankton, invertebrates and fish require sufficient levels of dissolved oxygen (DO) to survive. Each species has a DO threshold within which it can survive.

Dissolved oxygen (DO) refers to the concentration of molecular oxygen (O2) dissolved in water. Aquatic animals need oxygen to breathe and live, but they cannot use the oxygen in a water molecule (H_2O) because it is bonded too strongly to the hydrogen atoms (2H).DO is measured in milligrams per liter of water.



DO percent saturation depends on temperature (and also elevation, the deeper you go the less oxygen will be present). Percent Saturation is the amount of oxygen dissolved in the water sample compared to the maximum amount that could be present at the same temperature.

Oxygen is supplied to estuarine waters through three natural processes: (a) diffusion of atmospheric oxygen into the water, (b) aeration of water, and (c) photosynthesis by phytoplankton, aquatic seaweeds and seagrasses. **Diffusion** from the surrounding air into the water occurs as oxygen moves from an area of higher concentration to an area of lower. If the air in the atmosphere has a higher concentration of oxygen than the water - the oxygen is “pushed” into the water. The speed of this movement of oxygen is related to the difference in the concentration of oxygen in air to water and the barometric pressure. **Aeration** of water can occur during the mixing of surface waters by wind and waves. **Photosynthesis** is a chemical reaction that occurs in plants as they “breathe” in carbon dioxide and release oxygen into their environment. Macroscopic plants, such as marsh and bay grasses, and microscopic plants, such as phytoplankton, also oxygenate the water as a product of photosynthesis. Large daily fluctuations in DO are characteristic of areas that have extensive plant growth. As a result of photosynthesis, DO levels rise throughout the day, reaching a peak in mid-afternoon. Since photosynthesis stops at night, but organisms continue to respire, DO levels are lowest just before dawn.

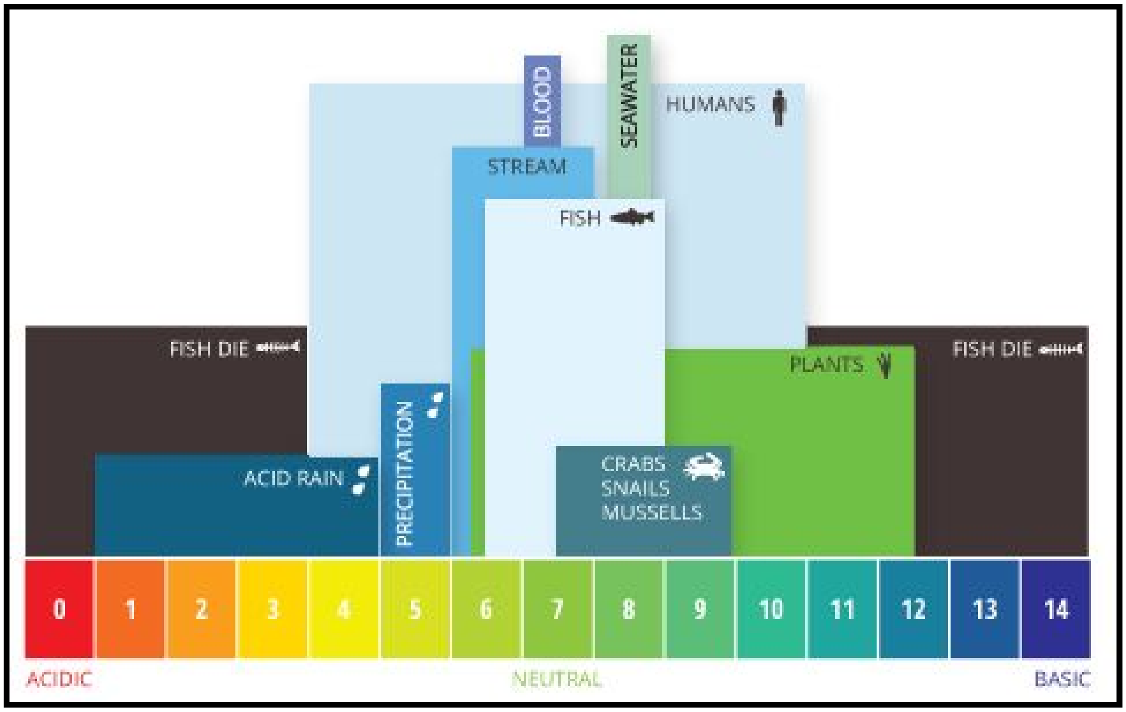
Oxygen is removed from estuarine water in two natural processes: (a) aerobic respiration and (b) bacterial decomposition. **Respiration** is a process in which animals and plants take up oxygen and produce carbon dioxide. During the process energy from sugars is also released. Respiration occurs all the time, while photosynthetic production of oxygen by plants occurs only during daylight hours. As a result, dissolved oxygen levels in an estuary may vary widely because of differences in the amount of oxygen produced by plants. **Decomposition** by bacteria, fungi, and other organisms affect DO levels in an estuary because they consume oxygen while breaking down organic matter. These decomposers consume oxygen in the process of gaining energy through the breaking of chemical bonds in organic matter.

Oxygen depletion may occur in an estuary when many plants die and decompose, or when runoff or poorly treated wastewater containing large amounts of organic matter enters the estuary. In some estuaries, large nutrient inputs, normally from sewage or fertilizer, stimulate phytoplankton blooms. When these organisms die, their bodies fall to the bottom of the estuary and begin to decompose. The decomposition process depletes the surrounding water of oxygen and, in severe cases, may lead to anoxic (very low or no oxygen) conditions that kill bottom-dwelling organisms. Shallow, well-mixed estuaries are less susceptible to this phenomenon because wave action and circulation patterns can easily supply the waters with oxygen.
Text Sources:
http://mddnr.chesapeakebay.net/eyesonthebay/lesson_plans/do_lesson_plan.pdf
https://coast.noaa.gov/data/estuaries/pdf/dissolved-oxygen-in-an-estuary-combined-teacher-student.pdf

pH Background

pH stands for the “potential of hydrogen” and it is a measure of acidity. pH ranges from 0 (extreme acid) to 14 (extreme base) with 7 being neutral. When you measure pH there are no units needed because pH is simply on a scale of 0-14.

Lemon juice has a pH of 3, which makes it an acid. Lemon juice stings if it gets in a cut, and stronger acids even have the ability to eat through solid objects. On the other end of the scale, bleach has a pH of 11, which makes it a base. Strong bases, just like acids, can burn your skin. How do strong acids and bases compare to the middle of the pH scale? Pure water has a pH of 7 and therefore is considered neutral. Our bodies are made mostly of water. Things that are close to pH 7 work well with our bodies. If we were to drink something that is extremely acidic or extremely basic, it could make us sick or kill us.



The same holds true for organisms that live in the water (i.e. aquatic organisms). If the water becomes too acidic or basic, it can kill them. Most organisms that live in an estuary need the pH to be between 6.5 and 8.5. pH levels in an estuary generally range from 7.0 to 7.5 in the areas with more fresh water influence, to a range of 8.0 to 8.6 in the areas with more salt water. The slightly basic pH (greater than 7 on the scale) of salt water is due to bicarbonate that comes from the weathering and erosion of rocks on land as water runs downhill toward the estuary or ocean.

The pH of water is critical to the survival of most aquatic organisms. Many species have trouble surviving pH levels below 5.0 or above 9.0. Changes in pH can also change other aspects of the water's chemistry, which may harm aquatic organisms. For example, if the pH levels are lowered, toxic metals in the estuary's sediment can be resuspended in the water column. This can harm many aquatic species. pH is an important indicator of water that is changing chemically in the water.

The pH of the estuary can be affected by the minerals dissolved in the water, aerosols and dust from the air, human-made wastes and by photosynthesis and respiration of organisms. Human activities that cause significant, short-term fluctuations in pH or long-term acidification of a waterbody are extremely harmful. For example, acid rain on the river of an estuary can diminish the survival rate of eggs deposited there by spawning fish. Another example is that algae blooms cause pH to change dramatically within just a few hours, which stresses the organisms.

Other factors that influence the pH of the water, include:

- bacterial activity;
- water turbulence;
- chemicals in runoff flowing into the waterbody;
- sewage overflows; and
- impacts from other human activities both in and outside the drainage basin (e.g., acid drainage from coal mines, accidental spills, and acid precipitation).

Image Source:
http://www.fondriest.com/environmental-measurements/parameters/water-quality/ph/

Overview of Water Quality Tests and Equipment

Below is some general information about the water quality test results you can expect to find for Newtown Creek. More detail is provided for each test and the rationale behind performing the test within the Lesson and Activities Materials.

If you are studying:	**Perform the following tests:**
Food Webs	dissolved oxygen, nitrates, pH
Sewersheds or Combined Sewer Overflows	dissolved oxygen, fecal coliform,
Tides, seasonal changes	temperature, salinity, pH
Pollutants	temperature, dissolved oxygen, nitrates, turbidity, fecal coliform

Recommended Test Kits

Test	Example	Measure	Results	What it Indicates
Temp.	 Measured using a shielded Celsius thermometer.	A measure of the average kinetic (heat) energy of molecules in the object.	Varies based on the season at the site of an external input such as ground water or effluent. Ranges from approximately 4 - 23°C (39 - 71°F)	Temperature can influence water density, physical and biological processes of aquatic organisms and distribution of aquatic organisms.
Salinity	 Measured using a SeaTest or Instant Ocean hydrometer with an indicator arm that floats based on the density of the water.	A measure of the amount of salt and other dissolved solids in the water.	Varies based on tidal flow and freshwater discharge. Ranges from 10 ppt to 22 ppt	Salinity can influence water density and can affect vertical stratification of water column. Salinity is also an important habitat variable as a number of aquatic species have a limited salinity tolerance.
Dissolved Oxygen (DO)	 Measured using a CHEMets Dissolved Oxygen kit with a chemical reagent ampoule and color comparator.	The amount of oxygen dissolved in the water.	Varies based on temperature, salinity, algae growth, sewage input, diffusion and aeration, photosynthesis, respiration and decomposition. Ranges from 0.1 ppm to 8 ppm	Dissolved oxygen will influence the survival or presence of marine organisms (e.g. fish, shellfish, macro and micro invertebrates, phytoplankton, fungi and bacteria).

Test	Example	Measure	Results	What it Indicates
pH	 Measured using Carolina Universal pH indicator strips.	A relative measure of acidity/ alkalinity.	Varies based on a large number of factors including CO2 levels in the water, salinity or freshwater input, and sewage input. Ranges from mildly acidic (6.2) to mildly alkaline (7.9)	pH can influence how marine organisms access nutrients and how they reproduce and grow (shells and skeletons grown by many marine organisms do not grow well in mildly acidic pH).
Turbidity**		Measures clarity of water using a turbidity tube. Dark colored water can be clear and not turbid.	Varies based on the amount of sediment or particles in the water coming from soil erosion, runoff, algal blooms, or sewage Test results range from 0 - 100 JTU (Jackson Turbidity Unit).	Excess sediments block sunlight from passing through water, which make it difficult for aquatic plants to photosynthesize and reduces food sources for fish.
Nitrates*	 Measured using a CHEMets kit with a chemical reagent ampoule and color comparator.	A water soluble form of nitrogen and an essential nutrient for living things.	Varies based on amount of sewage, industrial runoff and fertilizer that enters a water body. Test results range from 5 ppm to 40 ppm	High levels of nitrate causes excess plant growth and decay which increases harmful bacteria. Excess nitrate decreases the amount of oxygen available in water.

Test	Example	Measure	Results	What it Indicates
Coliform Bacteria*	 Measured using a Coliform Test kit with a lactose broth that changes color if coliform bacteria are present after a 48-hour incubation period at room temperature.	A presumptive test of the presence of total coliform bacteria.	Varies based on the amount of sewage or other fecal matter in the water Ranges from 4/100 mL to 109,000/100 mL	Fecal coliform bacteria indicate the presence of sewage contamination of a waterway and the possible presence of other pathogenic organisms.
All-in-One	 The GREEN Low Cost Estuary & Marine Monitoring Kit	An all-in-one kit that includes test for coliform bacteria, salinity, dissolved oxygen, biochemical oxygen demand, nitrate, pH, phosphate, temperature, and turbidity.	Less expensive than buying the above kits separately, but will need to be replaced as it only has enough materials to test ten water samples (two for coliform).	See above.

** Testing for Nitrates and Coliform Bacteria are bonus tests that can be performed at the teachers discretion, they are not included in the following Lesson Activities.*
***Turbidity is only included in the Field Lesson.*

These recommended test kits were chosen based on their ease of use, durability and their rapid result time.

Tips for Teachers

- If you do not have time to do all the tests in class, complete the tests before the class meets again, so you can still include the results in your discussion.

Vocabulary

Note: Some of this vocabulary is referenced in other parts of this curriculum. All vocabulary and definitions appear in the glossary of the curriculum.

Background Vocabulary:

analyze
average
control
data
decrease
dependent variable
hypothesis
independent variable
increase
mean
median
measure
mode
photosynthesis
precipitation
salt marsh
variable
water cycle

Essential Vocabulary:

aerate
brackish
buoyancy
coal tar
combined sewer overflow (CSO)
contamination
density
dissolved oxygen
estuary
eutrophication
fecal coliform
industrial
metadata
nitrates
non source point pollution
nutrients
ph
remediate
Respiration
runoff
salinity
saturate
sediment
sewage
silt
stagnant
temperature
tide
trend
turbidity
water quality

Extension Vocabulary:

algal bloom
dredge
green infrastructure
industrial
retention tank

Lesson I Water Quality Test Kit Practice

PLEASE NOTE: These lessons were purposefully written with built-in flexibility. You are encouraged to adapt the time, materials, procedures and handouts to fit your students, your teaching and your school.

Activity Overview

Water quality is important for the health of Newtown Creek's ecosystem. A variety of tests reveal different indicators that help determine the health of the waterway. Students will have the opportunity to practice using the water quality test kits in the controlled environment of the classroom using neutral tap water. By performing the water quality tests, students will practice the skills that will be applied later in the field. Students will also become familiar with how salt, pH, and oil interact with water and how these elements can be easily modified to impact the water.

In Activity 2, students will explore creating conditions similar to Newtown Creek and begin to understand the diverse characteristics of different types of waterways (freshwater vs. saltwater). Before a site visit, it is advisable to devote at least one class period for students to practice the tests and learn to use the equipment. The success of your field testing will depend upon the ability of your students to perform tests properly.

Learning Objectives

- Students will describe different water quality tests and what they measure.
- Students will perform water quality tests with improving accuracy.
- Students will make predictions about water quality results in Newtown Creek.
- Students will understand the importance of water quality in nearby waterways like Newtown Creek.

Time

45-90 minutes

Vocabulary

Try to incorporate vocabulary words from the "Water Quality Introduction" word list throughout the lesson.

Tips for Teachers

- Consider using and/or modifying portions of the water quality introduction as a text for your students.
- Depending on the age and experience of your students, your class may need to practice simple measuring techniques with plain water before performing the

tests. For example, some students have difficulty pouring water into a test tube to a certain metered line, or squeezing just one drop of water from a dropper.

- Even though students will only fill out a small portion of it during this lesson, hand out the water quality data sheet. Your experience in the field will go more smoothly if the students have seen the data sheet prior to being in the field.

Materials

- 4 one-gallon buckets (1 for each water quality test) half-filled with tap water
- 4 aluminum baking pans (placed under water buckets, to catch spills)
- Towels or paper towels
- Clipboards
- Graduated cylinder
- Pipette droppers
- Water quality test equipment/ kits:
  - Temperature
  - Salinity
  - Dissolved Oxygen
  - pH
- Water Quality Data Sheets
- Water Testing Test & Procedures Worksheets
  - Test & Procedures - Dissolved Oxygen
  - Test & Procedures - pH
  - Test & Procedures - Salinity
  - Test & Procedures - Temperature

Procedure

1. Set up four stations for water quality tests, one for each test.
2. Separate students into small groups (ideally, the same groups they will work with in the field).
3. Before, they perform water quality tests, students should practice pouring water from the sample bottle to specific metered lines, such as 5 mL.
4. Students should practice using pipettes. Have them add a specific number of drops (such as one, five and ten) to a sample using the pipette.
5. Because of surface tension, water in a test tube or graduated cylinder takes on a concave shape called the meniscus. Students should read the water level by looking at the tube at eye level and reading from the bottom of the meniscus.
6. Hand out the Water Quality Data Sheet and review.

7. Hand out the Test & Procedures worksheets.Student groups rotate to water quality testing stations. At each station, students read the background information and procedure for each test
8. Students perform the water quality test and fill out the Water Quality Data Sheet.
9. Students answer questions on the Test & Procedures worksheet.
10. Recombine students into new groups so they are now with other students that had different tests.
11. Students in the new groups share what they learned about their tests and demonstrate how to perform their test with the goal of identifying similarities and differences between the different test and test procedures.

Activity #2 Create Your Own Creek Water

In order to create water conditions similar to the conditions of Newtown Creek, students will add materials to tap water and perform water quality tests for pH and salinity. During the procedure, teachers can project vocabulary terms related to the content of the activity, as many of these terms will be new to students.

Learning Objectives

- Students will understand that water conditions in Newtown Creek, a tidal estuary, differ from the water conditions of tap water.
- Students will be able understand the differences between freshwater and brackish water.
- Students will understand that Newtown Creek is a tidal estuary, and contains brackish water (a mix of of salt and freshwater).
- Students will learn how it's possible to mimic and alter pH and salinity in various marine environments.

Materials for all Tests

- Journals
- Tapwater
- Measuring cups
- Tablespoon
- 1 one-gallon bucket for each student group
- Stirrer (a spoon or tablespoon will work)

pH Test Materials

- 2 containers or cups for each group
- White vinegar or lemon juice
- Baking soda

Salinity Test Materials

- Table salt
- 1 container of water (enough to fill hydrometer, more than one cup)
- Hydrometer for testing salinity

Procedure

Test #1: Measuring changes in pH

1. Divide students into small groups.
2. Explain the testing procedure to students.
3. Have students write down the procedure in their journals. Make predictions or record a hypothesis.
4. Each group gets 1 one-gallon bucket filled with tap water, plus 2 smaller containers (large enough to hold 1 cup of water)
5. Students test the pH of the tap water. Record data in journals. (*pH tests should be at or near neutral-7*)
6. Students measure and pour 1 cup of water into each of the smaller containers.
7. Students add 1 tablespoon of vinegar to one cup and 1 tablespoon of baking soda to the other cup. Stir until completely mixed.
8. Measure pH of both cups.
9. Record data on worksheets or in journals.
10. Repeat the above steps until noticeable changes are observed. Be sure to record data at each step.

Test #2 Measuring changes in Salinity

1. Explain the testing procedure to students.
2. Have students write down the procedure in their journals. Make predictions or record a hypothesis.
3. Each group gets 1 one-gallon bucket filled with tap water, plus 1 smaller container (with enough water to fill hydrometer with water)
4. Pour tap water into hydrometer. Record data in journals. (*salinity of tap water should be at or near 0*).
5. Pour water back into cup. Add 1 tablespoon of table salt, stir until completely dissolved.
6. Pour water back into hydrometer. Test for salinity, record data in journals.
7. Repeat until noticeable changes are indicated, up to 35 ppt (parts per thousand) which mimics the salinity of ocean water.

Discussion Questions

1. Why do we test for water quality?
2. What was your experience testing neutral tap water?

3. How does human behavior affect water quality? (Ask about specific tests.)
4. How does water quality affect Newtown Creek ecosystems?
5. What was your favorite part of the experiment?

Lesson II Dissolved Oxygen Lab

PLEASE NOTE: These lessons were purposefully written with built-in flexibility. You are encouraged to adapt the time, materials, procedures and handouts to fit your students, your teaching and your school.

Activity Overview

Animals need oxygen to breathe, including those that live underwater. The amount of oxygen available is directly related to the health of animals and the complex ecosystem they are a part of. Many factors influence the levels of oxygen in the water at any given time and place. Students will experiment with the water of different temperatures to delve deeper into factors that can affect the amount of dissolved oxygen in a water body.

Learning Objectives

- Students will describe two factors that influence the amount of dissolved oxygen in the water.
- Students will compare and contrast results of the dissolved oxygen experiment.
- Students will analyze the results of the experiment in writing.
- Students will describe how dissolved oxygen is important to life.

Time

90-120 minutes

Vocabulary

See “Water Quality Introduction” for a list of vocabulary words from which to choose

Tips for Teachers

- Consider using and/or modifying portions of the Water Quality Introduction as a text for your students.
- This lab will go more smoothly with your students if you do each experiment yourself before introducing it to the class.

Materials

- Dissolved Oxygen Reading
- Dissolved Oxygen Lab Instructions
- Dissolved Oxygen Lab
- Water Samples
- Containers for Water (wide-mouthed jar, 1000mL, beaker, ect)
- Dissolved Oxygen (DO) test kits
- Waste Containers for consumable DO materials
- Equipment needed for chosen variables:
  - Hot Plate
  - Oven Mitts
  - Ice
  - Stirrer

Procedure

1. Students read and annotate Dissolved Oxygen Tests and Procedures worksheet.
2. Separate students into small groups.
3. Students share annotations with the group. What did they find most important?
4. Hand out Dissolved Oxygen lab Instructions and review with your students.
5. You may want to assign a job to each group member (e.g. recorder, group leader, timekeeper, ect.)
6. Hand out Dissolved Oxygen Lab.
7. Students complete Lab “Introduction”
8. Distribute materials needed for experiment.
9. Students fill out “Materials” section.
10. Students complete experiment and record results.
11. Once experiment is concluded collect all lab materials.
12. Have a place (e.g. poster, smartboard projection, whiteboard, ect) that each group can post their results for the whole class to see and copy.
13. Students complete “Procedure, Diagram and Results.”
14. Review Results Data Table with the class
15. Students complete “Graph, Discussion and Analysis.

Discussion Questions

1. What is a control and why is it important?
2. Do you think this data is accurate? Why or why not?
3. What difficulties did you encounter when doing the experiment? Which of these difficulties may have affected the data.
4. What trends do you see in the data?

5. Why do you think we got these results?
6. How do the variables we tested for relate to conditions you will find at Newtown Creek?
7. How is dissolved oxygen impacted?
8. Why is it important to understand how dissolved oxygen is impacted in the environment?

Field Lesson: Water Quality

PLEASE NOTE: These lessons were purposefully written with built-in flexibility. You are encouraged to adapt the time, materials, procedures and handouts to fit your students, your teaching and your school.

Activity Overview

Newtown Creek is a complex ecosystem. The health of the Creek depends on the quality of water and the environment surrounding the Creek. This is an opportunity to bring your students outdoors and have them interact with the Newtown Creek by making observations and inferences and testing the quality of the water using several different parameters.

Learning Objectives

- Students will practice making observations about the environment surrounding the Creek and predictions about the quality of water in the creek.
- Students will practice how to accurately measure at least one water quality parameter using water from the Creek.
- Students will interpret the results of each test and explain what might be impacting the test result.
- Students will draw preliminary conclusions about the health of the Newtown Creek based on the water quality data.
- Students will compare water quality data if tested multiple times.
- Students will begin to understand the relationship between the environment surrounding the Creek and the quality of water in the Creek.
- Students will experience the importance of being in the field at Newtown Creek to learn about real issues.

Time

Can vary from 60 minutes to several hours.

Vocabulary

See “Water Quality Introduction” for a list of vocabulary words from which to choose.

Tips for Teachers

- Choose one or more of the sites listed in the Newtown Creek Field Sites Information section of the Curriculum Introduction.
- Always visit the Field Site prior to bringing your students there.

- Consider using and/or modifying portions of the Water Quality Introduction as a text for your students.
- Each student group will collect a water sample and conduct one or more tests. Working in small groups will help these tests go smoothly and help guard against error.

Discussion Points

- For each discussion point, decide which teaching method works best for you and your students.
- Hypothesis/ predictions of the test results
- Importance of testing procedure/ protocols
- Importance of metadata (location, date, time, tide, ect)
- Testing once vs. testing multiple times and taking an average
- Impact of weather on test results
- Impact of time of year on test results
- Surface vs. deep water test results
- Upstream vs. downstream results
- Pollutants that may influence test results (e.g. sewage can impact dissolved oxygen)
- Other factors that may influence test results (the tide can influence salinity)
- Other observations about the Creek
- Stewardship of the Creek

Discussion Questions

1. How is the environment surrounding the Creek related to the health of the Newtown Creek?
2. How was your experience being in the field and testing the water in Newtown Creek?
3. What did the water quality test in Newtown Creek tell you about the health of the Creek?
4. Why is testing water quality in nearby creeks like Newtown Creek important?

Journal Prompts

We recommend having students write in their journals at the end of the field experience and consider some or all of the following questions. Also refer to the “Journal Writing” section of the Introduction & Methodology for more suggestions about journaling.

1. What observations do you think are important to note on your water quality data sheet? What observations did you make?
2. Why do we collect multiple results for the same water quality test?
3. Why should we always test the dissolved oxygen first?
4. How can the weather or precipitation impact water quality data.
5. What factors could be influencing dissolved oxygen? Salinity? pH? Turbidity? Nitrates? Fecal coliform?
6. What results would you expect to find if we compared the surface water with a deep water sample?
7. What results would you expect to find if we compared water quality at the top of the creek to water quality in the mouth of the creek.
8. Choose one water quality result that you think should be improved in the Newtown Creek. What could you design/ propose/ build within the Newtown Creek or watershed that could have a positive impact on this water quality parameter?
9. Alternatively, what other kind(s) of stewardship could you participate in that could improve the health of the water in the Newtown Creek? Explain.
10. What was the experience being in the field, Newtown Creek, like for you?
11. What did you learn about Newtown Creek?
12. Why is water quality important?
13. Why does the water in Newtown Creek need to be improved?
14. How was your experience working together and coming up with ways to improve the quality of the Creek?
15. What does it mean to improve the quality of water in a Creek and how will that help support the health of the ecosystems in the Creek?

Main Activity: Testing Water Quality of the Newtown Creek

Materials

- Clipboards
- Journals
- Water Quality Data Sheet and Tests & Procedures.
- Site map (For your chosen field site)
- Water quality test kit tools (Depending on which tests you choose to do)
    1. Bucket and line
    2. Cloud chart
    3. Wind speed gauge
    4. Dissolved oxygen test kit
    5. Thermometer (one for water, one for air)
    6. Hydrometer
    7. pH test kit
    8. Turbidity tube

9. Nutrient test kit
10. Fecal coliform test kit

- Calculator (Optional; for calculating averages)
- Hand sanitizer
- Fresh water (For rinsing equipment)

Procedure

1. Separate students into small groups
2. Hand out site map and a water quality data sheet to each group
3. Stand in a central area on the site with the whole class and compare the boundaries on the quadrant site map to where those boundaries are on the actual site. Point out where the boundaries are for the site.
4. Students make observations on site map, based on elements they notice are degraded (e.g. litter, floatables (plastic trash), oil, compacted soil, dilapidated bulkheads/waters edge) or other things that may impact water quality.
5. Students collect metadata information (date, time, cloud cover, location, tide, etc) and record on Water Quality Data sheet. Note: You may want to collect the metadata with the whole class, or you may assign this as a task to one or more small groups. It is important to collect metadata first because it sets the stage for the water quality tests.
6. Student groups test the water and record results.
7. Facilitate students sharing test results so that their data sheets are complete as possible.
8. Students calculate averages with the students.
9. Students complete the water quality analysis at the end of the data sheet.
10. Students clean their equipment and hands.
11. Bring site maps, water quality data sheets and all other collected data back to the classroom for use in the Applied Learning Lesson.

Extension Activity - Observe a Fish

Note: This activity is also included in the Flora & Fauna Field Lesson, and is represented here because is complements water quality studies.

Materials

- Clipboards
- Observation/Inference Chart
- Disposable (nitrile) gloves or hand sanitizer
- Small plastic fish tanks
- Marine Wildlife of Newtown

Creek field guide poster

Optional
- Organism collection and observation tools
  - Dip nets
  - Magnifying glass
  - Magnifying box
  - Ruler

Procedure - Set Up

1. This activity ***must*** be done along with an expert from Newtown Creek Alliance (NCA) at either the Living Dock or North Brooklyn Boat Club Field Site locations. Access without assistance can be dangerous or impossible.
2. Most of the optional materials listed in the materials list will be provided for the class.
3. Confirm the trip and NCA will set up the observational experiment. For additional information refer to Field Site location guides.
4. Before the trip to the Field Site, review the Marine Wildlife of Newtown Creek field guide poster to familiarize yourself and students with the different species that can be found in the waterway. Many of the smaller fish, shrimp, and crabs are commonly seen at these locations. If time allows, talk about the different parts of the fish.

Procedure - Observe the Fish!

1. Within the Living Dock are several crates that hold various substrate; ropes, oyster and mussel shells, rocks, etc. A variety of species like to use these substrate filled crates as habitat. When a crate is pulled from the water and held over a container, fish, shrimp, crabs, and other animals of all sorts fall into the container for viewing. An experienced professional from NCA will perform this task for the class. The container will be brought to a table set up for student viewing.
2. Carefully take a few fish, leaving the shrimp or crabs, out the container with a net and put them in a small clear plastic fish tank (plastic fish tanks work better than tupperware because the sides are clear and make for easier viewing)
3. The more fish and fish tanks you have, the better. This way students can break into small groups in order to observe the organism up close.
4. Students carefully observe the fish and respond to the following prompts on their Observation Charts or in their Journals:
   - Sketch the fish. Label all the parts of the fish. Include colors, patterns and approximate size (you can use a ruler)
   - How does it move? Is it a fast swimmer? Does it sit on the bottom or hang out at the top?

- What do its fins look like? How many fins does it have? Where are they located? What shape are they?
- Describe what the fish's mouth looks like. Is it pointed up? Is it very small or very wide? What do you think the fish eats with this mouth? (Note: small mouths of these fish indicate they feed primarily on plankton and other small organic materials in the water as opposed to the larger striped bass that has a larger mouth with teeth and feeds on other smaller fish)
- Describe the fish's camouflage and coloring. What color is the fish when you look DOWN at it from above? What color is the fish when you look UP at it from below? Why do you think the fish is colored in this way? (Note: this is called "countershading" and it is a type of dual camouflage protecting the fish from predators above and below.)

5. Students can use the Marine Wildlife of Newtown Creek field guide poster to identify your fish. (Fish caught in the creek are most likely silverside, killie or mummichog.)
6. There will be other marine-vertebrates and invertebrates in the container (shrimp, crab, sea squirts, etc). Inspect them with the magnifying glass or magnifying box and students should include observations about them on the Observation Chart or in their Journals.

Applied Learning: Designing Water Quality Improvements

PLEASE NOTE: These lessons were purposefully written with built-in flexibility. You are encouraged to adapt the time, materials, procedures and handouts to fit your students, your teaching and your school.

Activity Overview

All the lessons previously build up to this lesson where students can explore ways to apply their knowledge to the real world. Based on experience in the field and data gathering during the Field Lesson, students will either recommend a strategy for working towards improvement of the health in Newtown Creek or design an improvement to a specific parameter of water in the Newtown Creek.

Learning Objectives

- Students will understand the health of Newtown Creek depends on the water quality of the Creek.
- Students will review water quality data
- Students will compare and contrast to other water quality data (Newtown Creek Alliance or DEP)
- Students will discuss validity of results - what should be repeated or done differently next time.
- Students will practice applying their gained knowledge to a real world issue by creating a plan to design something that would help improve one or more of the water quality indicators (dissolved oxygen, pH, fecal coliform, nitrates).
- Students will understand what it means to recommend a strategy or design improvement to a local place that affects them and their community.
- Students will practice working in teams and sharing out design ideas with classmates.

Time

45-60 minutes

Vocabulary

See Water Quality Introduction for a list of vocabulary words from which to choose.

Tips for Teachers

- Remind students that they do not need to be proficient artists when doing sketches. Line drawings will surface

- Consider using and/ or modifying portions of the Water Quality Introduction as a text for your students.

Materials

Materials from Field Lesson

- Site Map
- Site Map - clean copy
- Water Quality Data Sheet
- Journal entries
- Other student work from Field Lesson (e.g. photographs, sketches)
- Google image of Newtown Creek Neighborhood
- Newtown Creek Alliance Water Quality Testing booklet, or NYC Department of Environmental Protection (DEP) Newtown Creek Water Quality Data. (Both of these can be found on the respective websites)

Design Procedure

1. Separate students into the same small groups they were in during the Field Lesson.
2. Project the Google Map of Newtown Creek Neighborhood.
3. Review the Field Sites visited during the Field Lesson.
4. Point out on the Newtown Creek map the location of the Field Site(s) visited. Consider pointing out the schools location or other recognizable landmarks in relation to the Field Site (or proposed design site).
5. Each student in the group shares some observations or thoughts about their field site based on their worksheets and/ or journal entries.
6. If you visited more than one Field Site during the Field Lesson, choose one on which to focus.
7. Use the Water Quality data Sheet to calculate averages if it was not completed in the field. (Do this as a class if the students don't yet know how to calculate averages)
8. Review the Discussion Questions below, referring to the information from your Field Lesson (i.e. Site Map, Water Quality Data Sheet, journal entries, ect).
9. Hand out the Newtown Creek Alliance Water Quality Testing booklet data or DEP Newtown Creek Water Quality Data or another set of comparison data.
10. Discuss the similarities and differences of their results to the closest location tested by the DEP

11. Students choose one water quality parameter they would like to see improved (e.g. dissolved oxygen, pH, turbidity, nitrates).
12. Students revisit their observations from the field and discuss what observations might be impacting the water quality.
13. Each student gets a copy of the Site Map.
14. Brainstorm ideas that will improve water quality at your Field Site.
15. Each student uses the brainstorm ideas to sketch the design for water quality improvements on a blank Site Map.
16. Each student presents and explains his/ her design to the group.
17. The group members critique each others' designs and write down the best elements from each sketch.
18. The group gets a blank copy of the Site Map.
19. The group works together to create ONE final design incorporating the best elements from each individual's design.
20. The group works together to write an explanation and defend each element of their design.
21. Groups recombine so all students are with new group members.
22. Each student shares the sketch and explains the design with the new group members.

Discussion Questions

1. Describe your Field Site, its location and what surrounds it.
2. What types of pollutants did you observe on the Field Site
3. What other observation did you make at your Field Site?
4. How do the results compare to the water quality ranges we would expect to see in the Newtown creek?
5. Are there any results that are surprising? Explain why.
6. Are there any results that are questionable? (e.g. a group knows they made a mistake while performing the test) Explain why.
7. How might one or more of the of the observations you made be impacting the water quality results?
8. How do your results compare to data in the NCA Water Quality Data document or other data set?
9. Which of your test results do you find most concerning? Why?
10. Which of your test results do you feel you should focus on improving? Why?

Common Core Standards

Lesson 1
English Language Arts Standards
Science and Technical Subjects

Key Ideas and Details
Grades 6-8

CCSS.ELA-LITERACY.RST.6-8.1
Cite specific textual evidence to support analysis of science and technical texts.
CCSS.ELA-LITERACY.RST.6-8.2
Determine the central ideas or conclusions of a text; provi de an accurate summary of the text distinct from prior knowledge or options.
CCSS.ELA-LITERACY.RST.6-8.3
Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.

Craft and Structure
Grades 6-8

CCSS.ELA-LITERACY.RST.6-8.4
Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6-8 texts and topics

Integration of Knowledge and Ideas
Grades 6-8

CCSS.ELA-LITERACY.RST.6-8.9
Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.

English Language Arts Standards
Writing: History/ Social Studies, Science, & Technical Subjects
Production and Distribution of Writing
Grades 6-8

CCSS.ELA-LITERACY-WHST.6-8.4
Produce a clear and coherent writing in which the development, organization, and style are appropriate to task, purpose and audience.

English Language Arts Standards
Reading; Informational Texts
Craft and Structure
Grade 6

CCSS.ELA-LITERACY.RI.6.4
Determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and technical meanings.

Lesson 2
English Language Arts Standards
Science and Technical Subjects
Key Ideas and Details
Grades 6-8

CCSS.ELA-LITERACY.RST.6-8.1
Cite specific textual evidence to support analysis of science and technical texts.
CCSS.ELA-LITERACY.RST.6-8.2
Determine the central ideas or conclusions of a text: provide an accurate summary of the text distinct from prior knowledge or opinions.
CCSS.ELA-LITERACY.RST.6-8.3
Follow precisely a multi step procedure when carrying out experiments, taking measurements, or performing technical tasks.

Craft and Structure
Grades 6-8

CCSS.ELA-LITERACY.RST.6-8.4
Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific or technical context relevant to grades 6-8 texts and topics.

English language Arts Standards
Writing: History/ Social studies, science, & Technical Subjects
Texts Types and Purposes
Grades 6-8

CCSS.ELA-LITERACY.WHST.6-8.1
Write arguments focused on discipline- specific content..
CCSS.ELA-LITERACY.WHST.6-8.1.C
Uses words, phrases, and clauses to create cohesion and clarify the relationships among claim(s), counterclaims, reasons and evidence.
CCSS.ELA.-LITERACY.WHST.6-1.D
Establish and maintain a formal style.
CCSS.ELA-LITERACY.WHST.6-8.1.E
Provide a concluding statement or section that follows from and supports the argument presented.

Production and Distribution of Writing
Grades 6-8

CCSS.ELA-LITERACY-WHST.6-8.4
Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

Research to Build and Present Knowledge
Grades 6-8

CCSS.ELA-LITERACY-WHST.6-8.7

Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.

English Language Arts Standards
Speaking & Listening
Comprehension and Collaboration
Grades 6-8

CCSS.ELA-LITERACY.ACY.SL.6-8.1
Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 6-8 topics, texts, and issues, building on others' ideas and expressing their own clearly.

Mathematics Standards
Standards for Mathematical Practice
Grades 6-8

CSS.MATH.PRACTICE.MP2
Reason abstractly and quantitatively.
CSS.MATH.PRACTICE.MP4
Model with mathematics.
CSS.MATH.PRACTICE.MP5
Use appropriate tools strategically.
CSS.MATH.PRACTICE.MP6
Attend to precision.

Mathematics Standards
Statistics & Probability
Grade 6

CCSS.MATH.CONTENT.6.SP.B.4
Display numerical data in plots on a number line, including dot plots, histograms, and box plots.
CCSS.MATH.CONTENT.6.SP.B.5
Summarize numerical data sets in relation to their context, such as by:
CCSS.MATH.CONTENT.6.SP.B.5.A
Reporting the number of observations.
CCSS.MATH.CONTENT.6.SP.B.5.B
Describing the nature of the attribute under investigation, including how it was measured and its units of measurement.

Next Generation Science Standards
MS. Matter and Energy in Organisms and Ecosystems

` MS-LS2-1
Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.
MS-LS2-4

Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.

Field Lesson

English Language Arts Standards

Science and Technical Subjects

Key Ideas and Details

Grades 6-8

CCSS.ELA-LITERACY.RST.6-8.3

Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6-8 texts and topics.

Craft and Structure

Grades 6-8

CCSS.ELA-LITERACY.RST.6-8.4

Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6-8 texts and topics.

English Language Arts Standards

Writing: History/ Social Studies, science, & Technical Subjects

Texts Types and Purposes

Grades 6-8

CCSS.ELA.LITERACY.WHST.6-8.1

Write arguments focused on discipline-specific content.

CCSS.ELA.LITERACY.WHST.6-8.1B

Support claim(s) with logical reasoning and relevant, accurate data and evidence that demonstrates an understanding of the topic or text, using credible sources.

Production and Distribution of Writing

Grades 6-8

CCSS.ELA-LITERACY.WHST.6-8.4

Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

Research to Build and Present Knowledge

Grades 6-8

CCSS.ELA.LITERACY.WHST.6-8.7

Conduct a short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.

English language Arts Standards

Speaking & Listening

Comprehension and Collaboration

Grades 6-8

CCSS.ELA-LITERACY.ACY.SL.6-8.1
Engage effectively in a range of collaborative discussions (one-to-one, in groups, and teacher-led) with diverse partners on grade 6-8 topics, texts, and issues, building on others ideas and expressing their own clearly.

Next Generation Science Standards

MS. MAtter and Energy in Organisms and Ecosystems

MS-LS2-4
Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.

Applied Learning

English Language Arts Standards

Grades 6-8

CCSS.ELA-LITERACY.RST.6-8.3
Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.

Craft and Structure

Grades 6-8

CCSS.ELA-LITERACY.RST.6-8.4
Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6-8 text and topics.

English Language Arts Standards

Writing: History/ Social Studies, Science & Technical Subjects

Text Types and Purposes

Grades 6-8

CCSS.ELA-LITERACY.WHST.6-8.1
Write arguments focused on discipline-specific content.

CCSS.ELA-LITERACY.WHST.6-8.1B
Support claim(s) with logical reasoning and relevant, accurate data and evidence that demonstrate an understanding of the topic or text, using credible sources.

Production and Distribution of Writing

Grades 6-8

CCSS.ELA-LITERACY.WHST.6-8.4
Produce a clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience

Research to Build and Present Knowledge

Grades 6-8

CCSS.ELA-LITERACY.WHST.6-8.7
Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.

English Language Arts Standards
Speaking & Listening
Comprehension and Collaboration
Grades 6-8
CCSS.ELA-LITERACY.SL.6-8.1
Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 6-8 topics, texts, and issues, building on others' ideas and expressing their own clearly.
CCSS.ELA-LITERACY.SL.6-8.1.B
Follow rules for collegial discussions, set specific goals and deadlines, and define individual roles as needed.
CCSS.ELA-LITERACY.CCRA.SL.1
Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively.
Grade 6
CCSS.ELA-LITERACY.SL.6.1.c
Pose and respond to specific questions with elaboration and detail by making comments that contribute to the topic, text, or issue under discussion.
Grade 7
CCSS.ELA-LITERACY.SL.7.1.c
Pose questions that elicit elaboration and respond to others' questions and comments with relevant observations and ideas that bring the discussion back on topic as needed.
Grade 8
CCSS.ELA-LITERACY.SL.8.1.c
Pose questions that connect the ideas of several speakers and respond to others' questions and comments with relevant evidence, observations, and ideas.

Next Generation Science Standards
MS-ETS1-1
Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
MS-ETS1-2
Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

Additional Resources:

Texts:

- **"Water Quality Monitoring," by Sam Wagner; Newtown Creek Alliance**

http://www.newtowncreekalliance.org/water-quality-monitoring-by-sam-wagner/

- **"Swimmer braves stinky New York City Canal on Earth Day," Scientific American article**

https://newsela.com/read/swim-pollutedwater/id/9057/

- **"Teens find and test streams to reintroduce Virginia's brook trout," Washington Post article**

https://newsela.com/read/students-saving-brook-trout/id/43196/

- **Dissolved Oxygen in an Estuary (Teacher Resource)**

https://coast.noaa.gov/data/estuaries/pdf/dissolved-oxygen-in-an-estuary-combined-teacher-student.pdf

- **Teacher's Guide The Harlem/Hudson Interpretive Project (Teacher Resource)**

https://drive.google.com/file/d/0B2aiebDFrsKxNU5sRVFMdHBZXzg/view?ts=5b685ba6

- **Newtown Creek Alliance Water Quality Testing Booklet**

http://www.newtowncreekalliance.org/water-quality-sampling/

ELA or Social Studies Texts

- ***A River Ran Wild: An Environmental History* by Lynne Cherry**
  https://www.amazon.com/River-Ran-Wild-Environmental-History/dp/0152163727

- ***Riparia's River* by Michael J. Caduto**

https://www.amazon.com/Riparias-River-Michael-J-Caduto/dp/0884483274

- ***Water Rolls, Water Rises: El agua rueda, el agua sube* by Pat Mora; (English and Spanish edition)**

https://www.amazon.com/Water-Rolls-Rises-English-Spanish/dp/0892393254

Videos:

- **The Invisible Creek**

https://www.youtube.com/watch?v=m0OFd3PRk50&feature=youtu.be

- **Swimming the Newtown Creek in New York City**

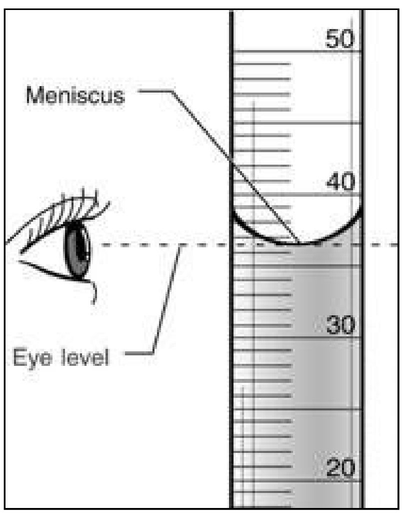
https://www.youtube.com/watch?v=eJ_kYlzIBx4

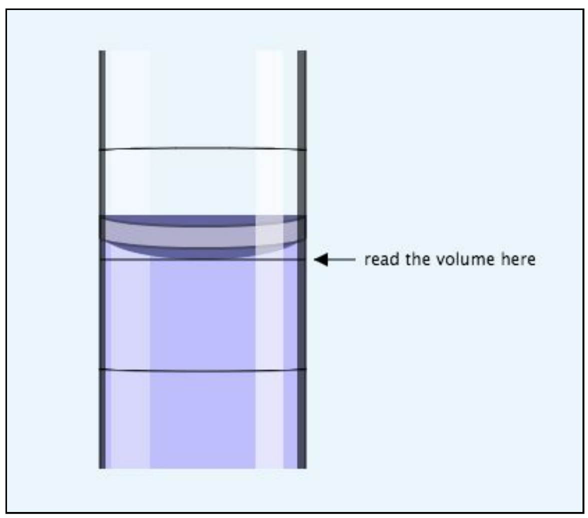
- **"A Billion Gallons a Day," New York Times**

https://www.nytimes.com/video/nyregion/100000003176142/living-city-a-billion-gallons-a-day.html

Images:

Reading Water Levels/Meniscus Line:





Handouts

Newtown Creek Water Quality Data Sheet

Student Name: Name of Site: Water Body:

Description of Site

______
______
______
______
______
______
______
______

Time

Year: __________ Month: __________ Day: __________ Local Time: __________ am/pm

Weather

Precipitation in last 48 hours? YES/NO Current Weather: ________

Cloud Type: ______________________________

Cloud Cover:

- O No Clouds
- O Clear (<10%)
- O Isolated clouds (10%-24%)
- O Scattered (25%-49%)
- O Overcast (>90%)
- O Broken (50%-90%)

Air Temperature: _______ °C _______ °F

High Tide: __________

Direction (set): __________

Ebb / Slack / Flood: __________

Wind Speed: __________ mph

Sea State: __________ (0-12)

Low Tide: __________

Speed (drift): __________ knts

Water Sample Depth: __________

Dissolved Oxygen

Observer Name:	Results:
1)	
2)	
3)	
	Average:

Water Temperature

Observer Name:	Results:
1)	
2)	
3)	
	Average:

Salinity

Observer Name:	Results:
1)	
2)	
3)	
	Average:

pH

Observer Name:	Results:
1)	
2)	
3)	
	Average:

Newtown Creek Water Quality Data Sheet

Student Name: Name of Site: Water Body:

Turbidity

Observer Name:	Results:
1)	
2)	
3)	
	Average:

Nutrient Test

Observer Name:	Results:
1)	
2)	
3)	
	Average:

Fecal Coliform Test (24 - 48 hour wait period)

Observer Name:	Results:
1)	
2)	
3)	
	Average:

Water Appearance

- O Foam
- O Muddy
- O Milky
- O Oily Sheen
- O Scum
- O Floatables
- O Other ____________________

Odor

- O Rotten Eggs
- O Musky
- O Acrid
- O Chlorine
- O None
- O Other ____________________

Water Quality Analysis

What do these results tell us about Newtown Creek?

Other Observations or Notes:

Field Site Metadata

Fill in the following information about the Field Site you are visiting

Student Name:

Location:

Site Name____

Time_______________ Day________________

Year_______________ Month______________

Weather Temperature:__________

Describe the weather:

Cloud Type:

Cloud Cover:

- ☐ No Clouds
- ☐ Some Clouds (Partly Cloudy)
- ☐ Lots of Clouds

Description of Site & Conditions:

Temperature Test & Procedures

Student Name:____________________________________Date:___________

Temperature Procedure

1. Carefully fill the sampling container with water.
2. Place the thermometer in the sampling container.
3. Leave the thermometer undisturbed for two minutes.
4. Leaving the bulb (bottom-most part) of the thermometer submerged in the water, pull the thermometer out of the water just enough to read the numbers.
5. Bring your eyes down to the level of the thermometer.
6. Record your result using the unit °C.

Temperature Questions

1. What do you predict the temperature of the Newtown Creek will be? (Remember to consider what time of year you will be measuring the temperature.)

2. What factors do you think causes the temperature Newtown Creek water to change?

3. Why is it important to monitor temperature in the Newtown Creek?

Salinity Test & Procedures

Student Name:____________________________________Date:___________

Salinity Procedure

1. Carefully fill the hydrometer with water – up to the skinny part of the neck.
2. Tap hydrometer down gently to release any bubbles.
3. Put hydrometer on a flat surface (the palm of your hand is not a flat surface!).
4. Bring your eyes down to the level of the hydrometer.
5. Look at the level of the plastic pointer and read the corresponding numbers that are measured in “PPT” (parts per thousand).
6. Record your result using the unit “ppt” (parts per thousand).

Salinity Questions

1. What do you predict the salinity of Newtown Creek will be? (Remember ocean water is approximately 35 ppt and fresh water is close to 0 ppt.)

2. Based on what you know, explain why the plastic pointer floats more with higher salinity.

3. Why is it important to monitor salinity in Newtown Creek?

pH Test & Procedures

Student Name:_____________________________________Date:___________

pH Procedure

1. Fill the 5mL test tube to the black line with sample water.
2. Put 10 drops of “pH indicator” in the test tube.
3. Place cap on test tube.
4. Invert test tube 10 times.
5. Place test tube in the comparator.
6. Record your results.
7. Dispose of sample water and indicator in a specified waste container.
8. Rinse out test tube with distilled water.

pH Questions

1. What do you predict the pH of Newtown Creek will be?
2. Based on what you know, what factors do you think causes the pH in Newtown Creek to change?
3. Why is it important to monitor pH in Newtown Creek?

Dissolved Oxygen Test & Procedures

Student Name:____________________________________Date:___________

Dissolved Oxygen Procedure

1. Carefully fill the sample cup (included in the test kit) with 25 mL of sample water.
2. Place one ampoule in the cup with the tip of the ampoule at the bottom corner of the cup.
3. Pull the top of the ampoule slowly but firmly towards the side of the cup until the tip breaks off.
4. Allow the ampoule to fill with sample water.
5. Take the ampoule out of the cup.
6. Dispose of the water left in the sample cup in a specified waste container.
7. Invert the ampoule, allowing the bubble to travel from one end of the ampoule to the other.
8. Invert the ampoule ten times.
9. Compare the amouple to the comparator by putting the ampoule in-between the comparator colors.
10. Record your result using the unit “ppm” (parts per million).
11. Rinse out the cup with distilled water.

Dissolved Oxygen Questions

1. What do you predict the dissolved oxygen in Newtown Creek will be?

2. Based on what you’ve learned, what factors do you think causes the dissolved oxygen in the Newtown Creek to change?

3. Why is it important to monitor dissolved oxygen in the Newtown Creek?