

Solve a Pollution Mystery

Understanding Ground Water Pollution
Pre Water Festival or Independent Lesson



nrdc.org

Description of Lesson

Students will be introduced to the threat of groundwater pollution and the impacts this may have to the surrounding natural environment. The activity encourages students to help 'solve a mystery' regarding a pollution incident in a fictional place. Although the community is a fictional town, the issue of water pollution and the possible affected habitats and are related to those found in Eastern Georgian Bay.

Connect with the Georgian Bay Biosphere

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GEORGIAN BAY
BIOSPHERE
MNIDOO GAMII
Spirit of the Water

Georgian Bay Biosphere: Lesson in a Backpack Program

At a Glance

Grade Level: 5

Learning Environment:
Classroom

Prep Time: 10 minutes

Length of Lesson: 40 minutes

Key Vocabulary: Pollution, fuel storage, wells, groundwater, aquifer, permeable, contamination, watershed, wetland, pollution source, contour, ecosystem, plume.

Staffing: 1 educator

Materials:
Each student requires...
A printer handout
Pencil
Highlighter
Other drawing utensils

Groupings: Pairs

Teaching/Learning Strategies:
Presentation, reading together, discussion, individual problem solving.

Lesson Outline

TIME	ACTIVITY	LOCATION	MATERIALS
40 minutes	Tracking Pollution Mystery	Classroom	
20 minutes	Extension Activity (Optional)	Gym or outside	A printer handout Pencil Highlighter Other drawing utensils

Curriculum Expectations

Gr. 5 Science and Technology

Understanding Life Systems: Human Organ Systems

Overall Expectations

1. Analyze the impact of human activities and technological innovations on human health.

Specific Expectations

- 1.1 Assess the effects of social and environmental factors on human health. Propose ways in which individuals can reduce the harmful effects of these factors and take advantage beneficial factors instead. Assess human impacts on biodiversity and identify ways of preserving biodiversity.

Understanding Structures and Mechanisms: Forces Acting on Structures and Mechanisms

Overall Expectations

1. Analyze social and environmental impacts of forces acting on structures and mechanisms

Specific Expectations

- 1.2 evaluate the impact of society and the environment on structures and mechanisms, taking different perspectives into account and suggest ways in which structures and mechanisms can be modified to best achieve social and environmental objectives

Understanding Matter and Energy: Properties of and Changes in Matter

Overall Expectations

1. Evaluate the social and environmental impacts of processes used to make everyday products

Specific Expectations

- 1.1 Evaluate the environmental impacts of processes that change one product into another product through physical or chemical changes
- 1.2 Assess the social and environmental impact of using processes that rely on chemical changes to produce consumer products, taking different perspectives into account and make a case for maintaining the current level of use of the product or for reducing it.

Understanding Earth and Space Systems: Conservation of Energy and Resources

Overall Expectations

1. Analyze the immediate and long-term effects of energy and resource use on society and the environment, and evaluate options for conserving energy and resources

Specific Expectations

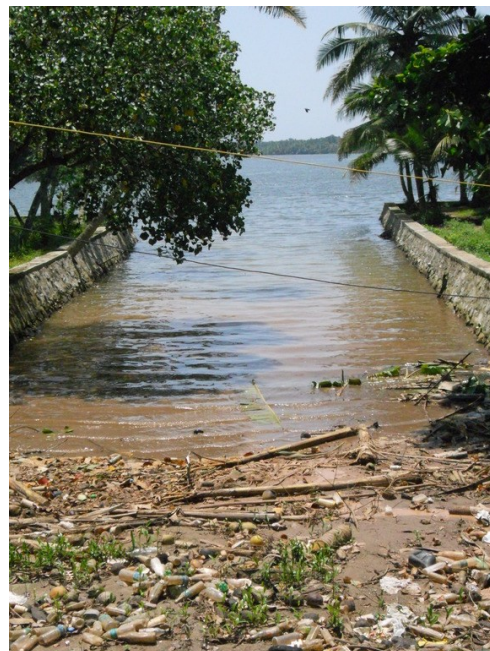
- 1.1 Analyze the long-term impacts on society and the environment of human uses of energy and natural resources, and suggest ways to reduce these impacts
- 1.2 Evaluate the effects of various technologies on energy consumption and propose ways in which individuals can improve energy conservation

Background

Water Pollution Sources

Surface and ground water sometimes become locally or regionally polluted. Sources of pollution include industrial and municipal discharge (sewage, excess water used in processing plant), urban and agricultural runoff (chemicals found in every day household cleaning and cosmetic products i.e. shampoo, soap, detergents, pesticides), spills (fuel spills above and underground), and airborne pollutants (exhaust). All of these pollution types may enter and cause harm to aquatic environments.

It can appear easy and simple to dispose of waste by dumping it into a river or lake – but this is wrong, and certainly does not dispose of the waste safely. Just because the waste seems to be distributed and disappear, this does not mean it has. A pollutant may easily re-appear downstream, change forms, bioaccumulate (become concentrated inside the bodies of living things) or dilute – but never disappear.



Water pollution can take many forms, including garbage and runoff.

Chemical Contaminants

Pollution contains chemicals that can be harmful to living organisms. Synthetic chemicals (those made by humans) are especially damaging because they're not natural and sometimes interact and react within an ecosystem in ways that are too complex to understand. What's worse, pollution can sometimes be very difficult to clean up or track. Chemicals affect wildlife by altering or destroying their habitat or ability to live normally. This may include a contaminated food source, or genetic effects that lead to developmental issues. Some species are naturally more resistant to chemicals in the environment, while others are not affected as much. Certain species may be able to change and adapt their certain habits to cope with living in a polluted environment. However, the only way a species can truly adapt its biological, chemical and physical characteristics to deal with a completely different environment is through evolution, which takes millennia! The pace at which humans are altering the natural environment is too fast and overwhelming for species to deal with. In recent years, humans have led to the alteration and disruption of countless habitats that have negatively affected entire ecosystems.

The activities at the start of the lesson introduce students to terms including: surface water, ground water, ecosystem, chemicals, ecosystem etc. The focus in this activity will be groundwater polluted by a leak in an underground fuel storage tank.

Teaching and Learning

Part A. Tracking Pollution Mystery

Divide class into pairs. Explain that each pair of students will work together as detectives to solve a mystery in a small town. Explain that the mystery cannot be solved unless you follow the mayor's directions step-by-step and complete each clue! Emphasize that the activity does not end once you find out who was responsible for the pollution. The following steps involving the effects on wetlands and species are just as important.

Hand out all related handouts and have students each have a pencil, highlighter and other colouring utensils ready.

Move through mystery hand-out with class.

Part B. Optional/ Extension Activity

Resources: Large topographic map of town and surrounding area (including Georgian Bay Biosphere).

'Culprit Activity' – Once all students have moved through activity and have discovered who the 'culprit' is, they can talk about the consequences that the town council and mayor may impose on the company that caused the pollution. Think of an appropriate fine, and/or another complimentary method such as ordering the company to clean up the spill and begin monitoring the ecosystem. What should the company do in the future?

Divide class into two. Ask class to look at, examine and interpret the contour lines on a map. Ask the class to find where they live, and other features like Killbear Park. Have them locate wetlands, lakes and rivers using the map and legend. Lead a conversation regarding pollution – where can pollution come from (i.e. headwaters, other rivers, larger towns), and where/how can pollution enter the water bodies close to their hometowns? Relate the conversation and guide answers to the likeness of the 'tracking pollution mystery activity' that was completed earlier.

Making a Cultural Connection

We must protect the water to protect ourselves, the ecosystems, and planet Earth. First Nations peoples have always been advocates for water. They protect their lands and waters by resisting the construction of new pipelines that carry gases.

What are the potential dangers and pollutants that the pipelines pose for both people and nature?

Traditionally, Aboriginal peoples believe that all things have a spirit. This includes rocks, water and soil. Water is considered to be sacred. It is life—it is a part of birth, and it sustains life afterwards.

Watch the video "The Sacred Relationship" at the following link: www.youtube.com/watch?time_continue=428&v=5NxBzyZ-8a4. This video is geared to an older audience and is close to an hour in length. Consider watching this to increase your own understanding. Share your knowledge.

Discussion Points

Many First Nations do not have access to water, have lost their access to water, or are at risk of losing their access to water. Not only do these people need water to live, but water also holds a sacred meaning for them.

Ask your students how their lives would be changed if suddenly their taps did not turn on, or their lakes were suddenly dried up or unsafe to swim in or drink from.

Unfortunately this is a reality for many Canadians and First Nations People.

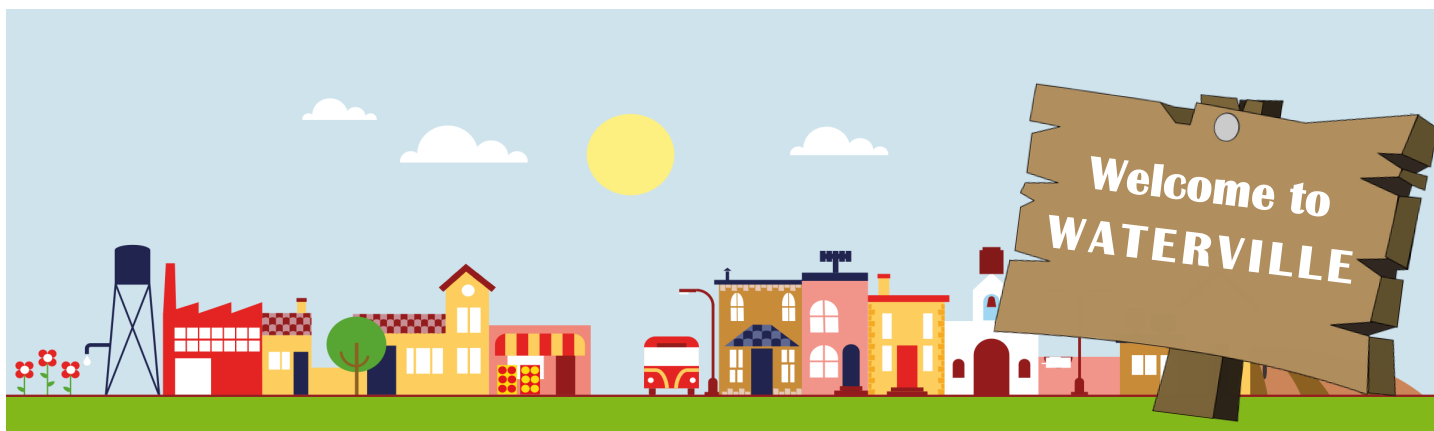
More information and stories can be found at www.wcel.org/program/sharing-stories/water

Lesson and information originally from www.sacredrelationship.ca/teach-about-water/.

Photo from: www.wcel.org/program/sharing-stories/water



Tracking Pollution Mystery



Detective _____ (your name)! The town of Waterville needs YOUR help! You have been hired as a secret detective to help the city solve a water pollution mystery! Follow the clues below to get to the bottom of this!

Here is what you will need:

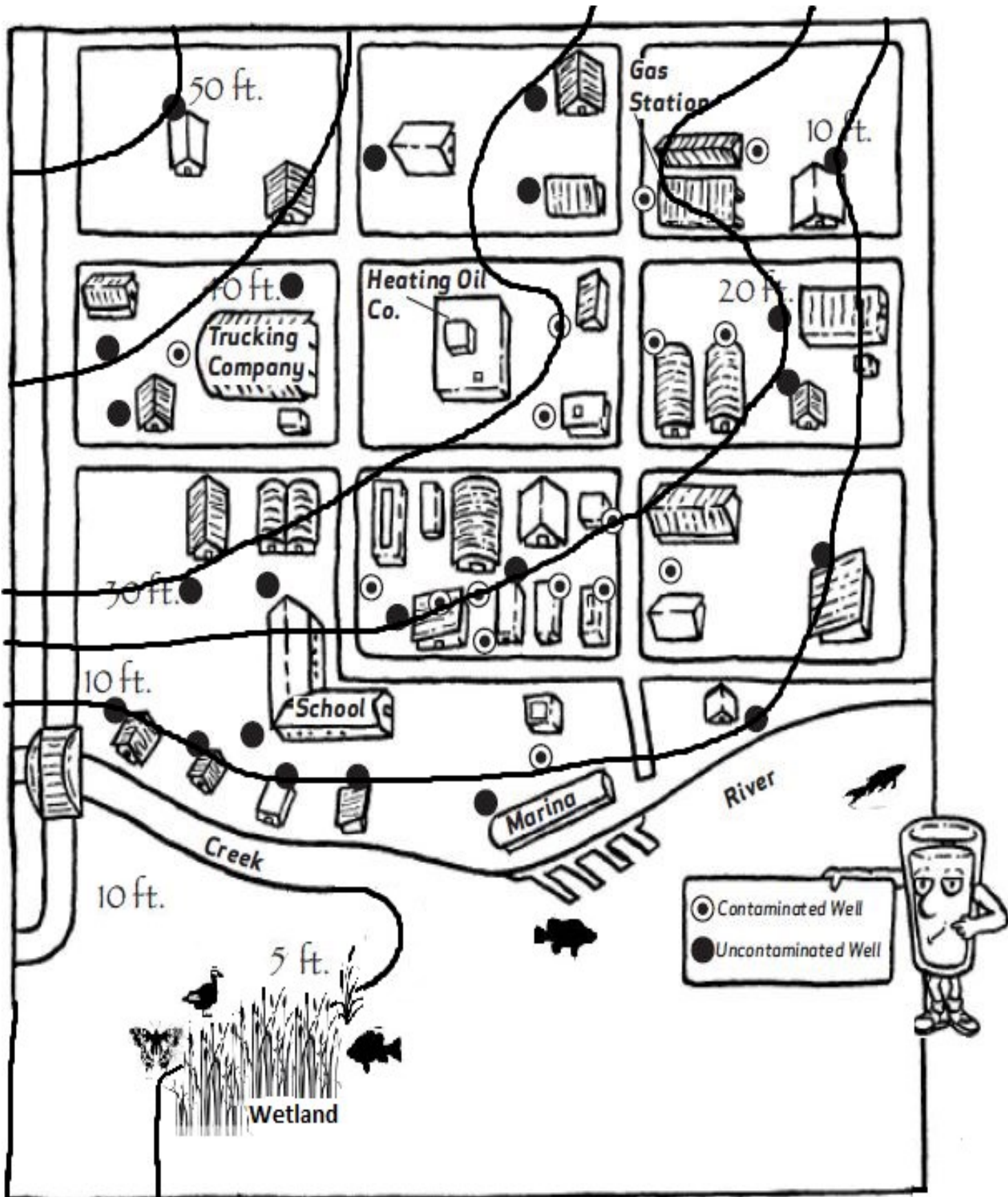
1. Pencil
2. Highlighter
3. Calculator

There are four clues that you must investigate and figure out in order to solve this mystery. Keep track by crossing them off below:

- Clue #1
- Clue #2
- Clue #3
- Clue #4

Before you start, I will tell you all that I know about what has been going on. The citizens in Waterville have been complaining that their drinking water tastes bad! The town is very small so most people have their own private wells. This includes businesses and schools too!

The mayor has provided you with a special map of the town. Here it is below:



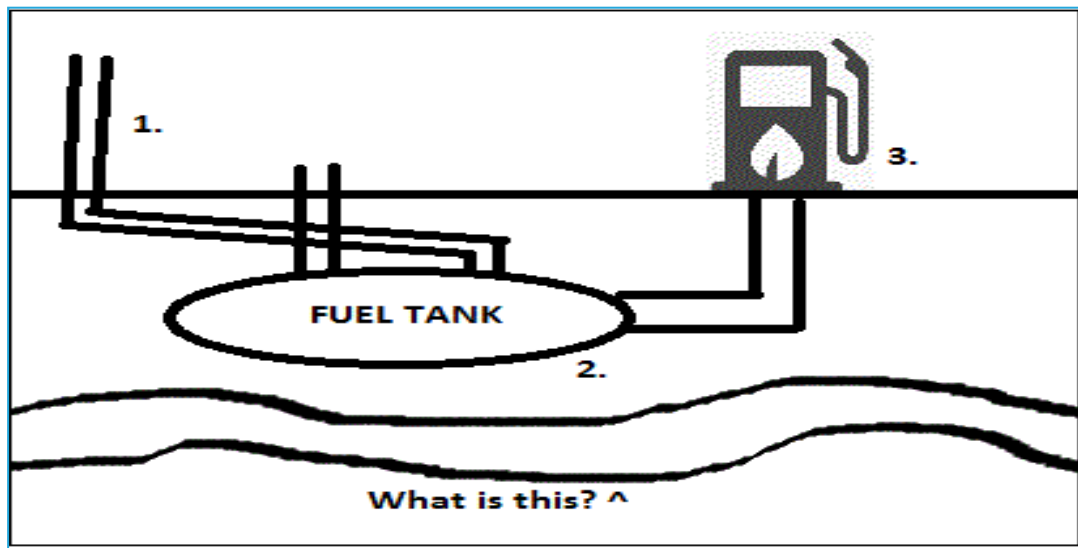
QUESTION: Looking at the map, how many wells are there in total?

ANSWER: _____

Clue #1: Scientists have tested the water from several wells in town, and found that the ground water has been contaminated with some kind of fuel! Oh no!

THINK: In what ways can fuel enter into the environment? Why is this important to understand?

Help the mayor by sketching where the fuel may have leaked out of on the picture below and by answering the following questions:



QUES-

How does pollution happen at the point labelled 1? Give one example & Draw it.

TION:

QUESTION: How does pollution happen at the point labelled 2? Give one example & Draw it.

QUESTION: How does pollution happen at the point labelled 3? Give one example & Draw it.

(Hint: What do we use fuel for?)

QUESTION: On the diagram, the mayor wrote “What is this?” Help him out by telling us what it is.

(Hint: one word)

Good work, Detective. Now we know how the fuel might have leaked into the water supply. Let's assess the damage. Look back at your town map to answer the following questions:

QUESTION: How many contaminated wells are there?

ANSWER: _____

QUESTION: What fraction of all the wells are contaminated?

ANSWER: _____

QUESTION: What percentage of wells in the town are contaminated? (Hint: You will need to use the total number of wells you counted!)

ANSWER: _____

QUESTION: What may these companies represent in terms of pollution?

Clue #2: The mayor has told you that there are three fuel companies in town that may be responsible for contamination. Take your highlighter and find the three companies.

ANSWER:

We have spoken to all three fuel companies.... And all three fuel companies say they have checked their underground storage tanks and are not responsible for any leaks.

WE NEED YOU TO HELP US FIND WHO REALLY DID IT!

Why is it important to prove who caused the pollution?

Answer:

LET’S START INVESTIGATING!

The map that they mayor gave you is a called a topographic map with contour lines.

QUESTION: What does “topographic” mean?

ANSWER:

QUESTION: What do ‘contour lines” represent?

ANSWER:

With your pencil, draw several perpendicular lines towards the line having the next lowest elevation

QUESTION: In which direction does ground water flow on your map?

ANSWER:

With your pencil, try and draw ONE loop around all the contaminated wells.

QUESTION: What do you think the area inside the loop represents?

ANSWER:

QUESTION: What can the loop tell you about the movement and spread of pollution?

ANSWER:

QUESTION: Based on contour lines and the locations of the contaminated wells, which company is the source of pollution?

ANSWER: _____

The contamination plume (or the loop you have drawn), will continue to spread slowly through the ground...

QUESTION: Where on the map you think the pollution will move to?

ANSWER:

QUESTION: Is there a sensitive area that may be negatively impacted? What is this ecosystem called? Circle it on your map.

ANSWER:

QUESTION: What types of animals may be found close to the contamination site? List at least three (*Hint: look at the picture below for a clue!*)

ANSWER: Three animals I think are in danger are:

QUESTION: Why are they in danger?

ANSWER: *These animals are in danger because:*

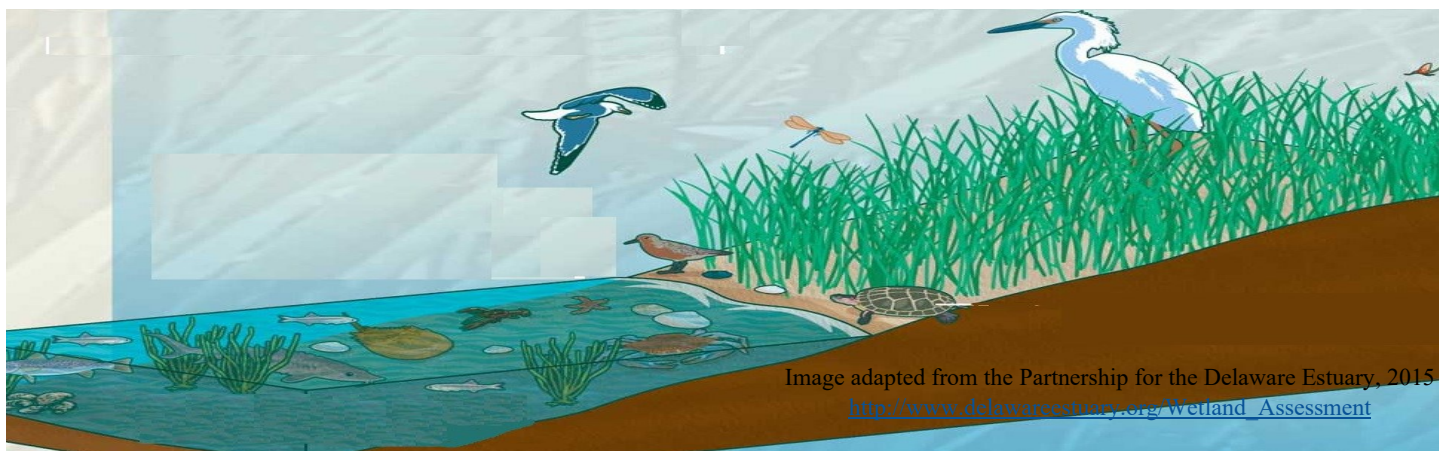


Image adapted from the Partnership for the Delaware Estuary, 2015
http://www.delawareestuary.org/Wetland_Assessment

You need to help the Mayor show the polluting company how the wetland will look like if they do not clean up the pollution. Help them by drawing!

If the pollution is NOT cleaned up....

Answer these questions by circling the correct response:

Are there going to be many animals and trees/plants living in this wetland?

YES NO

Are there going to be many insects living in this wetland?

YES NO

Is this wetland going to be very healthy?

YES NO

Is it important to clean up pollution and care about the environment?

YES NO



If the pollution IS cleaned up....

Answer these questions by circling the correct response:

Are there going to be many animals and trees/plants living in this wetland?

YES NO

Are there going to be many insects living in this wetland?

YES NO

Is this wetland going to be very healthy?

YES NO

Is it important to clean up pollution and care about the environment?

YES NO

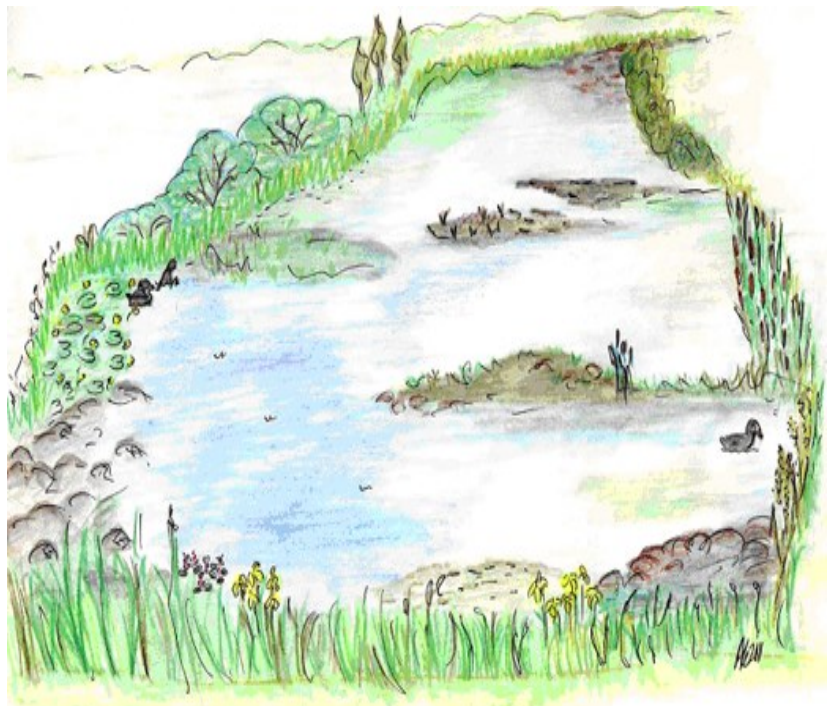


Image Source: <http://www.balticdeal.eu/measure/planning-a-wetland/>

TEACHER COPY: ANSWERS TO THE POLLUTION MYSTERY

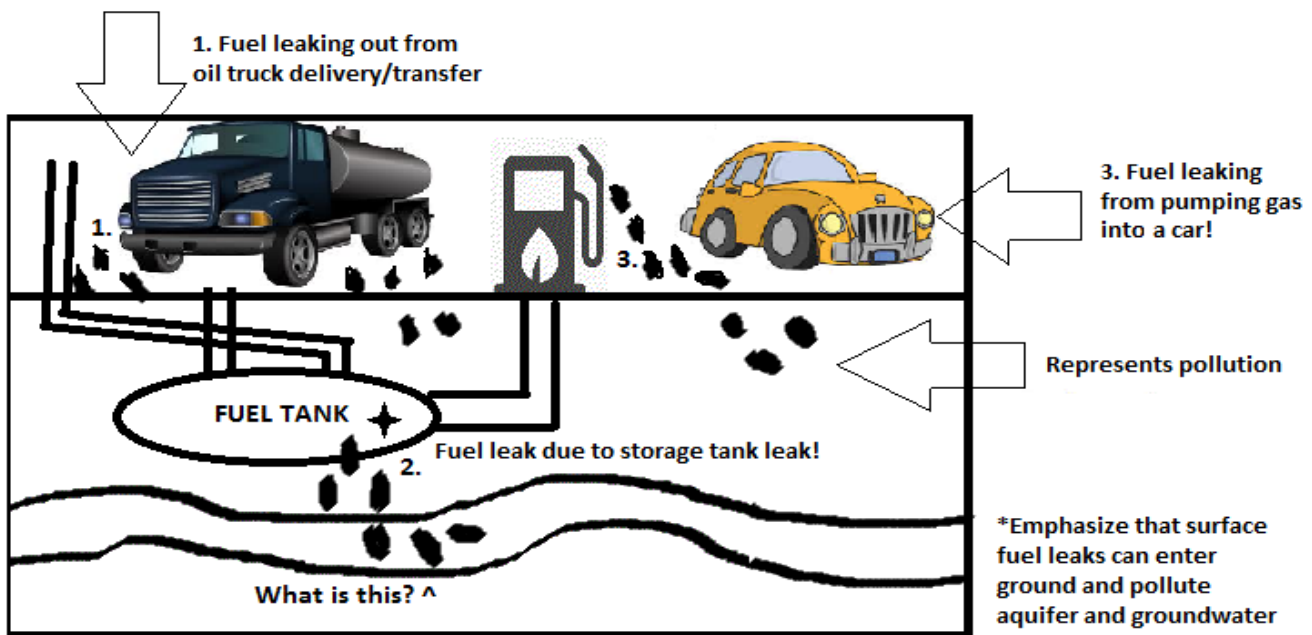
QUESTION: Looking at the map, how many wells are there in total?

ANSWER: 38

THINK: In what ways can fuel enter into the environment? Why is this important to understand?

ANSWER: *it is important to understand so that companies can check these areas for leaking fuel, and prevent pollution!*

Help the mayor by sketching where the fuel may have leaked out of on the picture below and by answering the following questions:



QUESTION: How does pollution happen at the point labelled 1? Give one example & Draw it.

ANSWER: *the fuel spills during transfer – like when you put gas into your car!*

QUESTION: How does pollution happen at the point labelled 2? Give one example & Draw it.

ANSWER: *Fuel tank leaking*

QUESTION: How does pollution happen at the point labelled 3? Give one example & Draw it.

(Hint: What do we use fuel for?)

ANSWER: *fuel can spill when a car's tank is being filled*

QUESTION: On the diagram, the mayor wrote "What is this?" Help him out by telling us what it is.

(Hint: one word)

ANSWER: *aquifer*

QUESTION: How many contaminated wells are there?

ANSWER: 16

QUESTION: What fraction of all the wells are contaminated?

ANSWER: 16/38

QUESTION: What percentage of wells in the town are contaminated? (Hint: You will need to use the total number of wells you counted!)

ANSWER: 42%

QUESTION: What may these companies represent in terms of pollution?

ANSWER: *point sources of pollution*

QUESTION: Why is it important to prove who caused the pollution?

ANSWER: *So the responsible company can clean it up quickly before it reaches the nearby wetland and other areas! ...Cleaning up ground water contamination is an expensive job, so you need to know exactly where the source is so that time and money aren't wasted cleaning up the wrong area!...impacts to other wells, groundwater supply etc....as well as impacts on ecosystems!*

QUESTION: What does "topographic" mean?

ANSWER: *detailed map of the surface features of land. It includes the mountains, hills, creeks, and other bumps and lumps on a particular hunk of earth*

QUESTION: What do 'contour lines' represent?

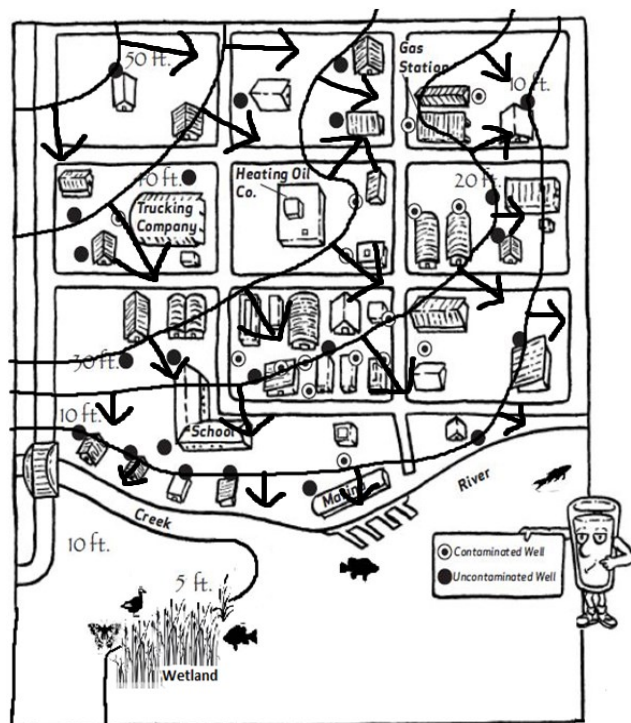
ANSWER: *a line on a map joining points of equal height above or below sea level.*

With your pencil, draw several perpendicular lines towards the line having the next lowest elevation

QUESTION: In which direction does ground water flow on your map?

ANSWER: downwards to water

With your pencil, try and draw ONE loop around all the contaminated wells.



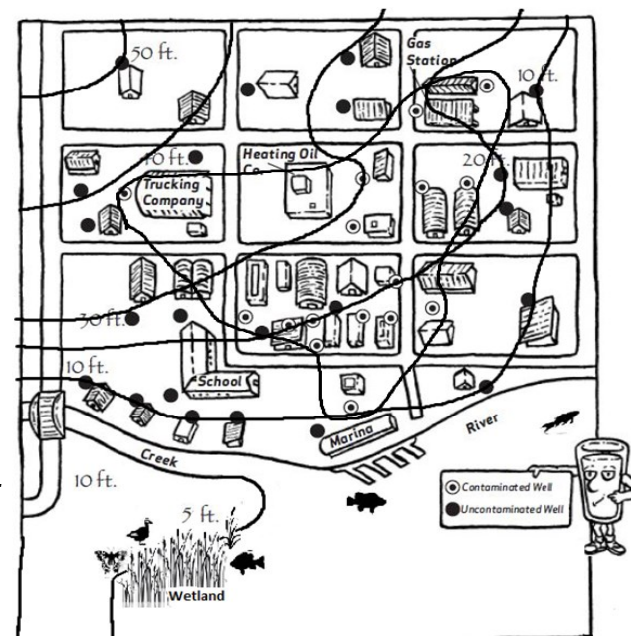
QUESTION: What do you think the area inside the loop represents?

ANSWER: where the pollution is located/ concentrated...this is called a contamination plume

QUESTION: What can the loop tell you about the movement and spread of pollution?

ANSWER: the pollution may be spreading in two directions – to top right and lower left

Based on contour lines (which show the movement of water) and the locations of the contaminated wells, which company is the source of pollution?



QUESTION: Based on contour lines and the locations of the contaminated wells, which company is the source of pollution?

ANSWER: The Trucking Company

QUESTION: Where on the map you think the pollution will move to?

ANSWER: the pollution will most likely move towards the lowest elevation (because of gravity), and eventually end up at the open water at the bottom of the map where it will disperse into the aquatic ecosystems

QUESTION: Is there a sensitive area that may be negatively impacted? What is this ecosystem called? Circle it on your map.

ANSWER: *Children should recognize that there is a wetland present on the lower left-hand side of the map. They can circle the wetland, and/or the shoreline areas where fish appear. Make sure to talk about both, and explain that the aquatic environment is one entire area that is sensitive to pollution. We focus on wetlands because these are habitats with a high number of species in one area, but less dense areas (i.e. open lake water) are still important to keep clean.*

QUESTION: What types of animals may be found close to the contamination site? List at least three (*Hint: look at the picture below for a clue!*)

ANSWER: Three animals I think are in danger are fish species, birds, insects, amphibians etc. Have children name specific species they know.

Drawing Section:

If Pollution is NOT cleaned...the wetland may look like this...

Are there going to be many animals living in this wetland? YES NO

Are there going to be many trees and plants living in this wetland? YES NO

Are there going to be many insects living in this wetland? YES NO

Is this wetland going to be very healthy? YES NO

Is it important to care about the environment? YES NO

-Have children think about what a healthy ecosystem looks like. In this case, the wetland they are drawing is unhealthy because the fuel company has not cleaned up the pollution. Have them add a limited number of species to the drawing. Have them draw in the oil spill/pollution. Emphasize how dangerous fuel and pollution can be to the living animals in this habitat.

If Pollution is cleaned...the wetland may look like this...

Are there going to be many animals living in this wetland? **YES** NO

Are there going to be many trees and plants living in this wetland? **YES** NO

Are there going to be many insects living in this wetland? **YES** NO

Is this wetland going to be very healthy? **YES** NO

Is it important to care about the environment? **YES** NO

-Have students think about what a healthy ecosystem looks like. They can refer to the picture at the bottom of the 3rd page of the handouts. In this case, the wetland they are drawing is healthy because the fuel company has cleaned up the pollution. Have them add a multitude of different species to the drawing.

For Teacher: Terms:

‘Aquifer’: a body of permeable rock that can contain or transmit groundwater.

‘Groundwater’: water held underground in the soil or in pores and crevices in rock

‘Permeable’: (of a material or membrane) allowing liquids or gases to pass through it.

‘Well’: a hole drilled into the ground to access water contained in an aquifer. A pipe and a pump are used to pull water out of the ground, and a screen filters out unwanted particles that could clog the pipe