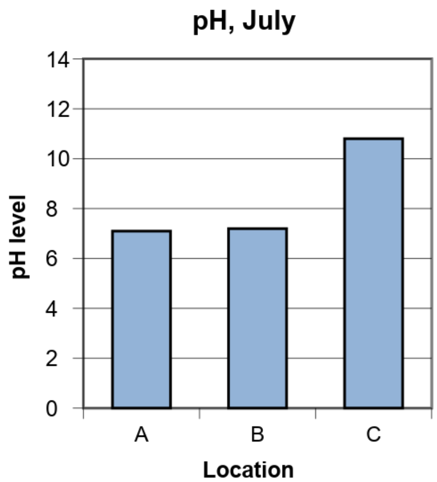
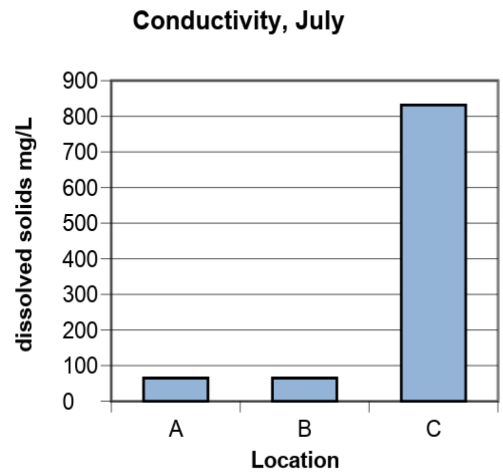
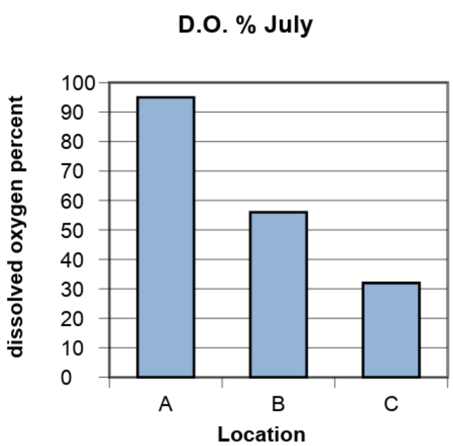
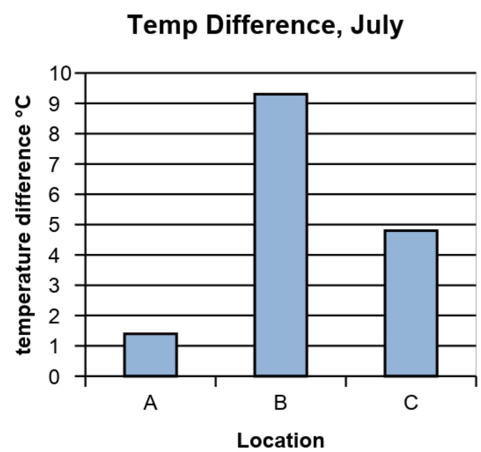
Blue River Water Quality Data Collection: July

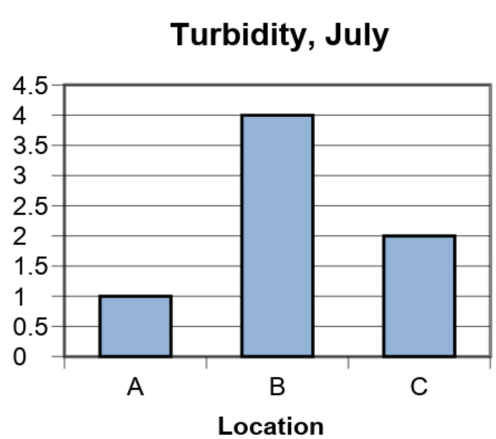


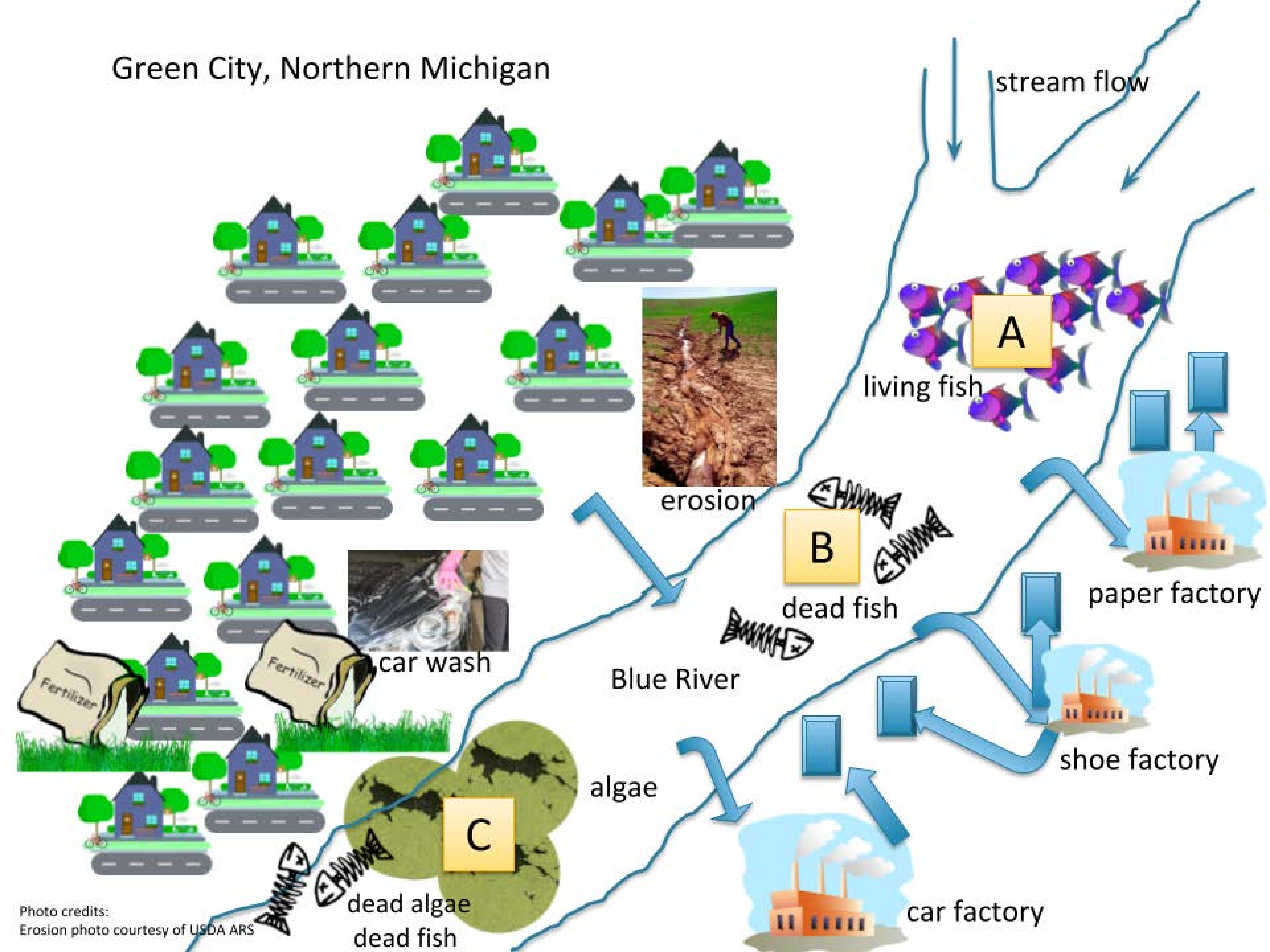






Turbidity Key	
1	None
2	Low
3	Medium
4	High




Green City, Northern Michigan
stream flow
erosion
living fish
A
B
dead fish
car wash
Blue River
paper factory
shoe factory
Fertilizer
Fertilizer
algae
C
dead algae
dead fish
car factory
Photo credits:
Erosion photo courtesy of USDA ARS

Name: ________________________________

Read the following scenario about the Blue River located in northern Michigan

Residents of Green City want to have a thriving community whose residents can experience a positive living environment that is also sustainable. This sustainable community will "meet their present needs without compromising the ability of future generations to meet their needs" (WECD, 1987). Part of their commitment to sustainability includes a pledge to keeping their water healthy while still meeting their needs.

Various water quality data have been collected in the river, but the residents don't know how to interpret the data because they don't know anything about water quality. Because of your expertise you have been commissioned by the residents of Green City to **write a scientific explanation** to help them answer the question, "***Is what we are doing on the land hurting the quality of the water?"*** and thus, potentially compromising their commitment towards sustainability. You are very famous however, and your time is very valuable and expensive so residents can only afford to hire you for 60 minutes.

1. LOOK at the PICTURE to see what people do on LAND and what is happening in the WATER at Locations A, B, and C. Next, study the GRAPHS and standards.

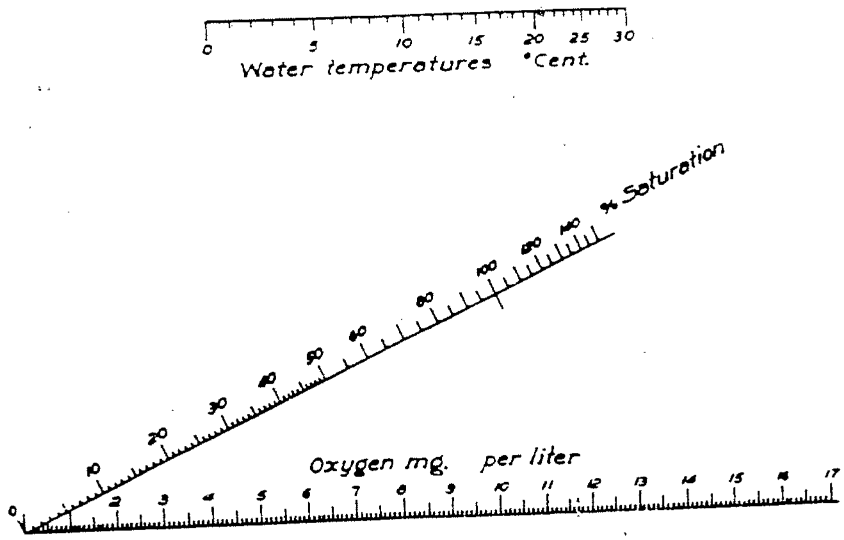
2. Analyze all of this information and then use it to write your scientific explanation to **explain to the residents WHAT is happening AT EACH LOCATION and how you know it, including WHY it is occurring,**

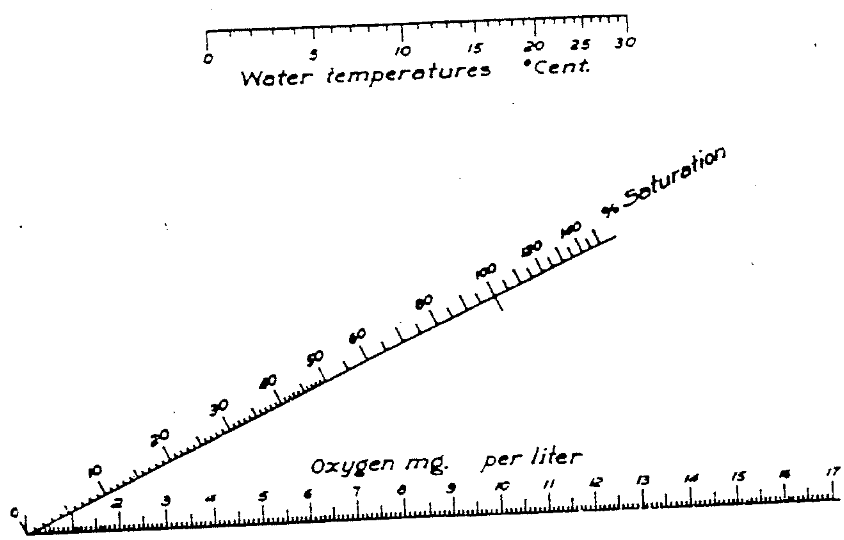
   a. WHY it is a problem - what harm it may do, and

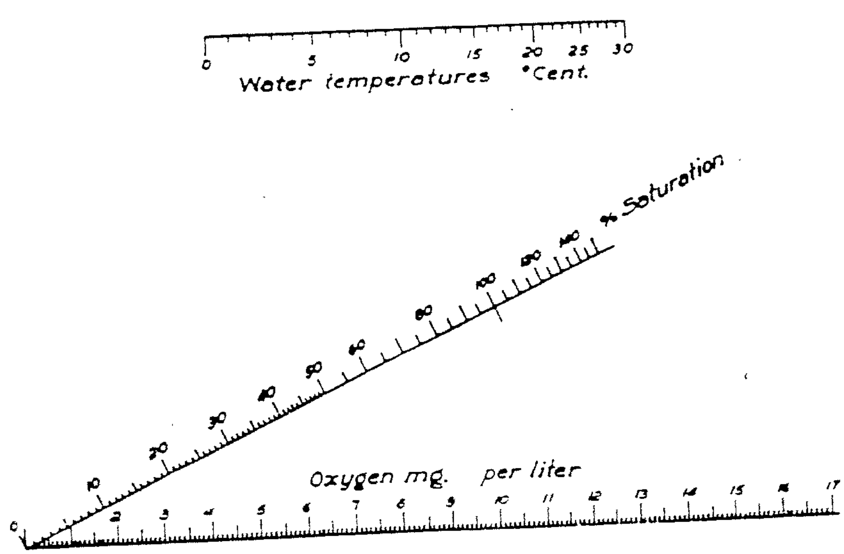
   b. WHAT action steps they can take on land to avoid the problem.

   If they are doing positive practices (as seen in the picture) be sure to let them know what they are and why they are positive.

You do not have the option of asking anyone to move or to close down any businesses. Look at all of the data at each location.


0 5 10 15 20 25 30
Water temperatures °Cent.
% Saturation
0 10 20 30 40 50 60 80 100 120 140
Oxygen mg. per liter
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17


0 5 10 15 20 25 30
Water temperatures °Cent.
% Saturation
0 10 20 30 40 50 60 80 100 120 140
Oxygen mg. per liter
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17


0 5 10 15 20 25 30
Water temperatures °Cent.
% Saturation
0 10 20 30 40 50 60 80 100 120 140
Oxygen mg. per liter
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17

Conductivity Data

Water Body: ________________________________   **Date: ________________________**

Conductivity (mg/L)	**Observations that could impact the stream's conductivity**
Trial 1 _____ Trial 2 _____ Trial 3 _____ Average: __________ Average divided by 2: __________	In the water: Near the water: Recent Weather:

What is the conductivity of everyday products people use on the land?

People use products outside on land that can get washed into storm drains or simply run downhill during rain or snowmelt and then flow into streams, rivers, and lakes. Some of these products contain substances that dissolve. Three of the major dissolved solids that impact water quality are road salt, nitrates, and phosphates. High amounts of these can cause problems for organisms in the water.

Conductivity Standards as wall as total nitrate and phosphate standards:

Dissolved Solids Water Quality Standards	**Conductivity probe**	**Total Phosphate**	**Nitrates**
Excellent – not too many dissolved solids	0-100 mg/L	0-1 mg/L	0-1 mg/L
Good - not too many dissolved solids	100-250	1.1-4	1.1-3
Fair - too many dissolved solids	250-400	4.1-9.9	3.1-5
Poor - too many dissolved solids	> 400	> 10	> 5

Conductivity Data

Substance	**Prediction**	**Results Trial 1**	**Results Trial 2**	**Results Trial 3**	**Result Average**	**Standard**

Dissolved Oxygen Data Table

Dissolved oxygen (DO) of fresh water body datasheet (available as a separate document)

D.O. mg/l	Temperature °C (degrees Celsius)	D.O. %	Standard	Observations that could impact the stream's DO
				In the water: Near the water: Recent weather:

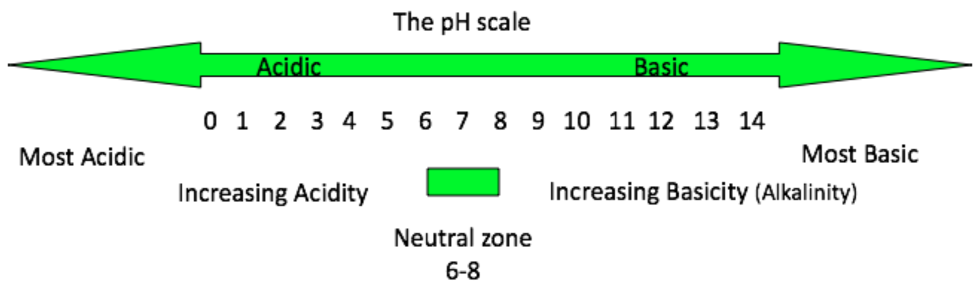
pH Data

Water Body: ________________________________ **Date:** ________________________

pH	**Observations of substances or conditions that could impact the stream's pH**
Trial 1 _____ Trial 2 _____ Trial 3 _____ Average: __________	In the water: Near the water: Recent Weather:

Are everyday products people use outside acidic, basic, or neutral?

We know that products we use on land can run downhill into storm drains or down a hill and end up in streams. If we test the pH of everyday products it can help us to understand why we might get the pH results when we go out to the stream to test for pH. Fill in each box. Use the pH scale provided to help you with your predictions and results. An example is provided.



pH Data

Substance	Prediction # - acid, base, neutral	Results Trial 1	Results Trial 2	Results Trial 3	Result Ave	Result: Acid, base, neutral
Antifreeze	4 weakly acidic	8.9	9.1	9.1	9.0	Weakly basic

Water Quality Test Results

How Healthy is our stream for freshwater organisms?

How do our actions on land potentially impact the water?

Organize your results from all of the water quality tests into one data table below. Notice the far right column labeled *Observations*. Record any information that you may have observed in or near the water that might help you determine what caused the results you obtained for that test.

Name of Water Quality Test	Results	Water Quality Standard	Observations

Temperature Data

Water Body: ________________________________ **Date: ________________________**

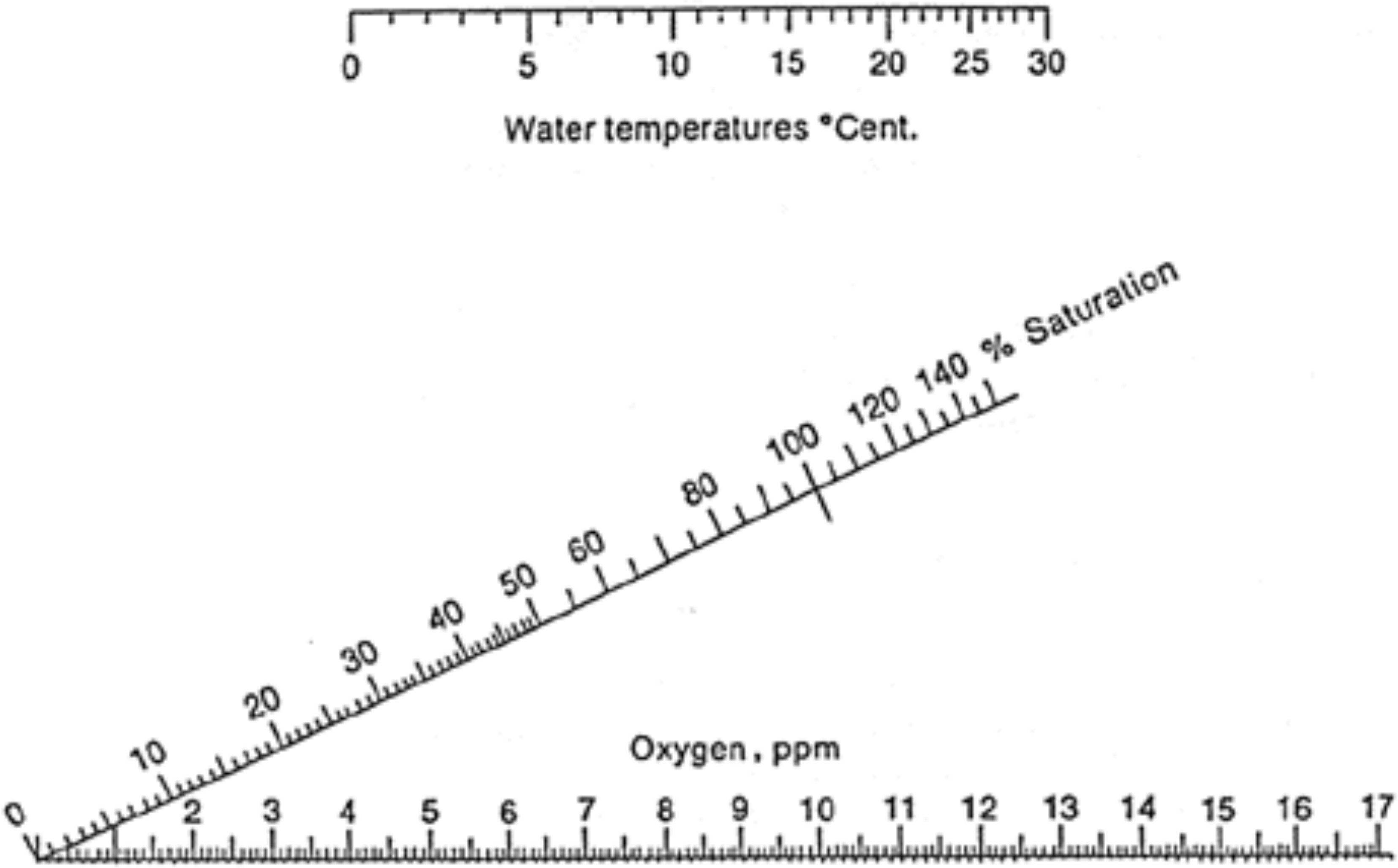
Temperature difference of the water body	**Observations that could impact the water body's temperature**
Water Temp 1 Water Temp 2 Difference (Subtract the two) Trial 1 ______ Trial 1 ______ __________ Trial 2 ______ Trial 2 ______ __________ Trial 3 ______ Trial 3 ______ __________ Average __________	In the water: Near the water:

Turbidity Data Table

Turbidity of fresh water body datasheet

Amount of turbidity	**Standard**	**Observations that could impact the stream's turbidity**
		In the water: Near the water: Recent weather:

Dissolved Oxygen (ppm) conversion to % Saturation



Source: http://www.waterontheweb.org/under/waterquality/oxygen.html

Name: ______________________________

Water Quality Scientific Explanation - Guide Sheet

Fill in each box with <u>notes</u> from your data and background. Next, use these notes to write up a complete explanation for the health of your stream based on the water quality test.

<table>
<tr><td>What question are you addressing? Which water quality test?</td><td colspan="2"></td></tr>
<tr><td>Make a <u>CLAIM</u>: Answer the question according to the test – How healthy? Can (all, most, some, few, none) organisms live here?</td><td colspan="2"></td></tr>
<tr><td><u>EVIDENCE</u>: Support your claim. Report BOTH Quantitative & Qualitative evidence.
● In the water
● Near the water
● In the area (watershed)</td><td><u>REASONING</u>: Explain and discuss evidence using Science Ideas:
WHAT do results mean? Positive/Negative? Consequences?
WHY did you get them (causes)? Relate to your water quality results. Tie science ideas and evidence together.</td><td><u>REBUTTAL</u>: Is there another possible cause or consequence you did not use to explain your results? What is it? Why did you choose it/them?</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td><u>ACTION STEP</u>: Include one action step specific to the water quality test. What can people do and how will this help? If positive results, what can people continue to do and why?</td><td colspan="2"></td></tr>
</table>

Water Quality Explanation Outline

Introduction	What question are you addressing? (Which water quality test?)
Claim	Statement: Answers the question with accurate relationships between variables (test results and organisms)
Evidence	Quantitative data and qualitative data that includes observations in, around, and near the water, plus weather
Reasoning	Explain the results connect science ideas with evidence: Are results positive or negative? Why? Include the causes and the consequences? Why do you think you got these results? What is the cause or source of the pollutant? Use the science to discuss your results – this will tie the science, your quantitative and qualitative evidence together.
Rebuttal	Are there potential causes that you can rule out? Why?
Action Step	What can people do to help and how will it help?

Name: ___________________________________

Water Quality Explanation Outline

Introduction

Claim

Evidence

Reasoning

Rebuttal

Action Step

Name: ________________________________

pH Lab set-up and experimental procedure

A famous science book publisher has hired you to design and write a lab set-up and procedure for conducting a lab that investigates the pH of various substances that can get into streams. In addition, she also wants you to create a data table where students will record their data.

What are the directions you will write to teachers to set up the lab? What procedure will students follow, step by step, during the lab? Write the lab set-up and lab procedure below.

<u>Lab set-up</u>:
(Directions to teachers)

A. Initial ideas

B. Lab Set-up

<u>Lab procedure</u>
(How to conduct the lab)

(OVER)

What will your data table look like? Draw a "sloppy copy" empty data table below.

How many dissolved solids are in our stream?
Dissolved Solids as a measure of Water Quality

Why do we measure for dissolved solids of streams? Where do they come from?

People use products outside on land that can get washed into storm drains or simply run downhill during rain or snowmelt and then flow into streams, rivers, and lakes. Some of these products contain substances that dissolve. Three of the major dissolved solids that impact water quality are road salt, nitrates, and phosphates. High amounts of these can cause problems for organisms in the water.

Road Salt – What is its source and how does it Impact Water Quality?

If you live in a northern climate you probably have experienced snowy winters. In addition to snow covered roads, ice and freezing rain can cause potential safety hazards. Road salt is put on surfaces - roads, sidewalks, and parking lots - to help avoid accidents [illegible] safe. Organisms in lakes, rivers, and stream are freshwater organisms not saltwater organisms. Although adding salt to slippery roads is important for safety reasons, too much salt can be a problem for freshwater organisms.

Nitrates and Phosphates – What are they and where do they come from?

Compounds that contain nitrates and phosphates can dissolve. For instance, sodium nitrate can dissolve in water. But what are they? Nitrogen and Phosphorus are both elements. In nature, nitrogen and phosphorous can be found in various compounds like sodium nitrate and potassium phosphates. Nitrates and phosphates are essential nutrients; all organisms need them for growth and repair. However, they are only needed in very small amounts. So where are nitrates and phosphates found? Well, if all living organisms need them, then all living organisms have nitrates and phosphates. But so do products that come from them, like animal waste. All dead organisms, then, have nitrates and phosphates. Another name for dead organisms is organic waste. This includes dead animals and plants. If you live in a climate where leaves change colors a[illegible] every year you are very familiar with dead leaves!

Dirt can hold nitrates and phosphates. So far, all of these sources are from nature. Nitrates and phosphates are essential components of the life cycle. When there is organic waste (dead plants and animals), decomposers such as bacteria break down the dead matter. During this process, nitrates and phosphates are released. On land, the nutrients go into the soil and are then used by plants for growth. In the water, water plants use nitrates and phosphates that are released from decomposition. Whether on land or in the water, animals eat plants and other animals. That's how they get nitrates and phosphates. Both the plants and animals eventually die and become organic waste and the cycle starts all over again. This cycle is important. Without it, new plants and animals would not be able to grow! Too many nitrates and phosphates in water, however, can cause significant problems for aquatic environments. A major source of excess nutrients (nitrates and phosphates) in waterways is fertilizer. Think abo lp their crops grow. People use fertilizer to have nice lawns and

When it rains, runoff from agriculture, lawns, and home gardens can flow downhill and into various waterways, contributing excess nutrients. Dairy farms have cows that produce waste. Cow manure and manure from other animal farms can also runoff into waterways. In addition, nutrients can come from leaking septic tanks and from wastewater treatment plants. Finally, some cleaners contain phosphates. These sources – fertilizer, human waste, animal waste from farms, and cleaners – come from people and result in excess nitrates and phosphates.

What is the effect (consequence) of excess nitrates and phosphates in waterways?

When there are too many nitrates and phosphates it can lead to a disruption of the life cycle that can eventually result in a **dead zone**. Dead zones are areas in water that cannot support life. A chain-reaction cycle occurs. First, excess nitrates and phosphates in water, often from fertilizer runoff, can result in excess algae growth causing algal blooms (remember that both nitrates and phosphates are nutrients for growth). Algae have a short life span. When all the excess algae die, there is an excess amount of organic waste. Do you remember what happens to organic waste? It is decomposed, broken down, by bacteria and other decomposers. If there is an excess amount of organic waste, there is an excess food source for bacteria. The bacteria population dramatically rises. Bacteria need oxygen. These excess bacteria use up all of the oxygen. Fish and other aquatic organisms need oxygen. Without it, they die. This results in more organic waste and the cycle starts again. Eventually, the oxygen is depleted (this cycle is also known as the oxygen depletion cycle) and the area becomes a dead zone.

How do we measure dissolved solids?

There are different ways to measure the amount of dissolved solids in water. One method is to use a conductivity probe. Dissolved solids can conduct electricity. For example, when put in water, sodium chloride (salt) breaks apart into sodium and chloride and can conduct electricity. Sodium nitrate breaks down in water to sodium and nitrate and potassium phosphate breaks down in water to potassium and phosphate and can conduct electricity. Though a conductivity probe can measure the ***amount*** of dissolved solids in a lake, river, or stream, it will not identify which solids are dissolved. Qualitative observations are used to help determine which solids might be dissolved in the water.

What would you look for **in** water that might indicate the possibility of nitrates and phosphates? _

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What **area** observations might indicate that people are using products on land that might contain phosphates and nitrates that could have entered water through runoff?

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If you live in a northern climate, winter weather could result in snow. High readings from a conductivity probe could be the result of road salt that has entered a waterway through run-off. Road salt, Calcium chloride, can break down and conduct electricity. In addition to conductivity probes, nitrate and phosphate kits are sometimes used. Here are the water quality standards for different ways of measuring the amount of dissolved solids:

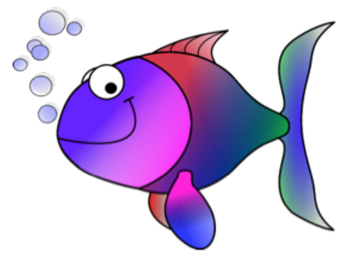
Dissolved Solids Water Quality Standards	**Conductivity probe**	**Total Phosphate**	**Nitrates**
Excellent – not too many dissolved solids	0-100 mg/L	0-1 mg/L	0-1 mg/L
Good - not too many dissolved solids	100-250	1.1-4	1.1-3
Fair - too many dissolved solids	250-400	4.1-9.9	3.1-5
Poor - too many dissolved solids	> 400	> 10	> 5

Whether due to road salt, nitrates, or phosphates, too many dissolved solids are not healthy for streams and organisms that live in streams. People's actions on the land can significantly impact the amount of these dissolved solids. Are there some action steps that you can think of that people can take to minimize the amount of dissolved solids that may enter waterways?

Is there enough oxygen for fish and other aquatic animals in the stream?
Dissolved Oxygen as a measure of water quality

What is dissolved oxygen (D.O.) and why is it important to measure?

Can you imagine what would happen if you didn't have enough air to breathe? Just like people, fish and other aquatic organisms need oxygen to live. Dissolved oxygen is oxygen gas that is in the water. Unlike many other water quality measures, high amounts of oxygen are positive for organisms in the stream! Fish don't have lungs, like people. Instead, fish have gills that allow them to breathe in oxygen that is in water. If there isn't enough oxygen in the water, fish and other organisms die. Trout is a type of fish that needs very high amounts of oxygen to live. That means that trout is an indicator fish. Carp, on the other hand, is a type of fish that can live in high and low oxygen levels.



If trout are spotted in a stream, what does it mean?

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____

Do you remember other water quality measures and the results that trout need to make the water hospitable?

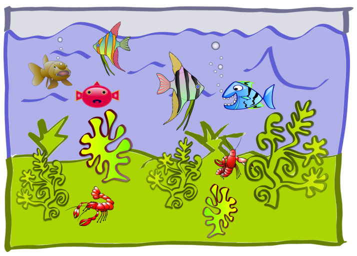
____

____

What are the sources of dissolved oxygen – where does it come from?

Have you ever seen water crashing against rocks as it flows downstream? At the bottom of a waterfall, have you observed the water as it hits the water below? The crashing water below a waterfall or against rocks causes turbulence.

Turbulent water can capture oxygen from the air. It traps the oxygen and pulls it into the water. The atmosphere, therefore, is one source of oxygen for streams. Any fast moving water that causes turbulence can capture oxygen from the air.



Another source of oxygen in stream comes from water plants. During photosynthesis plants produce oxygen. If the plants are on the land, the oxygen goes into the air. If stream, lakes, and rivers have water plants, when these plants produce oxygen, the oxygen goes into the water.

What causes oxygen levels to drop?

The main reason oxygen levels drop is due to excess organic waste. Organic waste is any decomposing waste from an organism. When plants and animals die they become organic waste. Waste from animals and raw sewage are also organic waste. When excess algae (often due to excess nitrates and phosphates) dies it becomes organic waste. Bacteria decompose organic waste.

Because there is an abundance of organic waste, the bacteria population dramatically increases. Bacteria also use oxygen. If there are excess bacteria they will use up all of the oxygen. Fish and other aquatic organisms die from lack of oxygen. This results in more organic waste. The cycle starts again. The end result may be an oxygen-depleted environment that can lead to a dead zone: a place that lacks the conditions necessary for life.

Another factor that could contribute to lower oxygen levels is thermal pollution. Warm water cannot hold as much oxygen as cold water. So if the water is abnormally hot its oxygen levels may be lower.

Water Quality Standards

Just like other water quality measures there are standards that are used to reflect if a fresh water body of water has enough oxygen.

Here are the water quality standards for dissolved oxygen:

Dissolved Oxygen Water Quality Standards	Dissolved Oxygen Percents
Excellent – plenty of oxygen	91-110%
Good – enough oxygen	71-91% or over 110%
Fair – not enough oxygen	51-70%
Poor – not enough oxygen	Below 50%

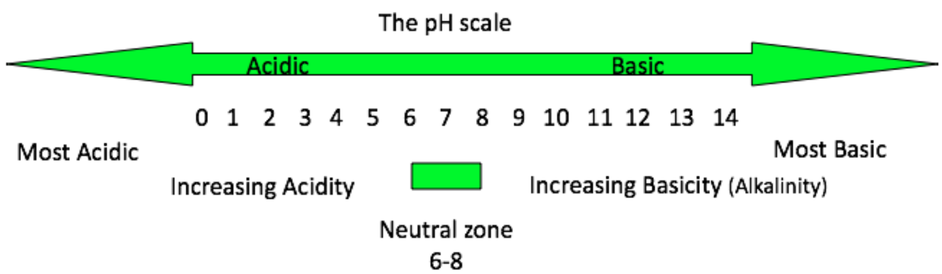
When you test your stream or river for dissolved oxygen, what results are you hoping to get? Can you explain why?

Student Reader, pH

Is the stream acidic, basic, or neutral? pH as a measure of Water Quality

What does pH measure?

pH is a water quality measure that determines if a stream, river, or any body of water is acidic, basic, or neutral. Look at the pH scale below and you'll see that it runs from a value of zero, which is very acidic, to 14, which is very basic. Right in the middle is 7, which is neutral.



Credit: Ann M. Novak

What is the pH range that is the best for freshwater organisms - the pH range that is the best for the majority of organisms? To find out, look at the chart below. Read the types of organisms and line them up with the pH scale. ____

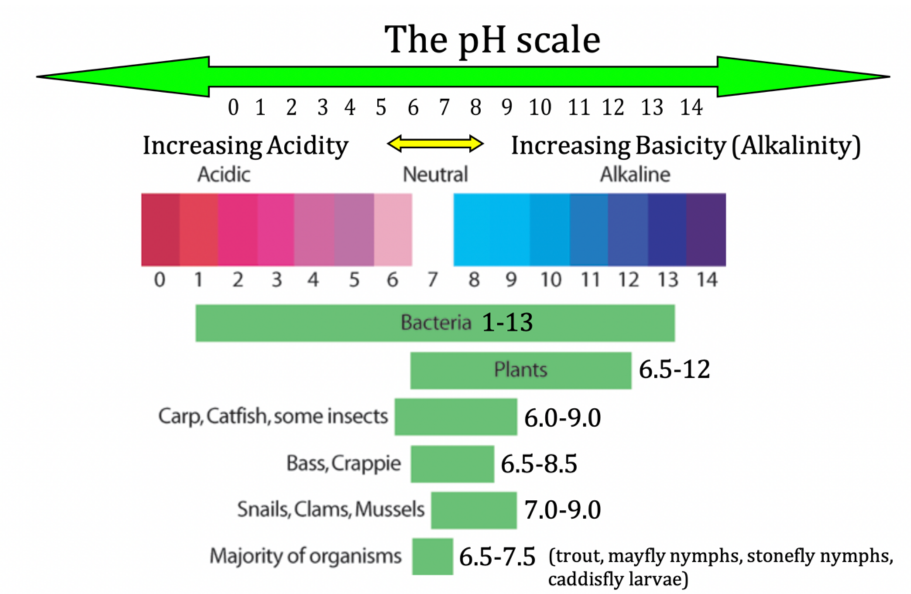
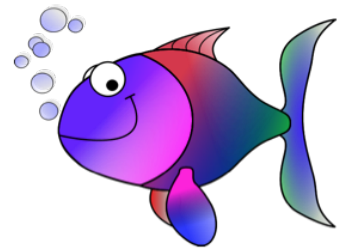


Chart modified from GREEN (Global Environmental Education Network), 1992

Student Reader, pH



Do you see that the majority of freshwater organisms need a pH between 6.5 and 7.5? This is the best pH range for freshwater organisms and would be considered excellent water quality for pH. Examples of organisms that need this pH range in order to live include trout, mayfly nymphs, stonefly nymphs, and caddisfly larvae.

Many other organisms can live in a pH range that falls between 6–8 on the pH scale. This is called the *neutral zone* for freshwater organisms. It's a pretty healthy pH for water and would be considered *good* water quality, even though 6.5-7.5 is the best. Look back at the pH scale. Do you see that 6-8 is labeled as the neutral zone? When we test the water quality of a river or stream (or any freshwater body) we hope that the pH is either excellent (pH between 6.5-7.5) or good (pH between 6.0-6.5 or 7.6-8).

What happens when the water's pH becomes more acidic or basic? Write down your guess.

____

If something causes a stream to become either too acidic or too basic, the organisms that need a more neutral pH will die. The water is no longer healthy for them. For example, trout, mayfly nymphs and stonefly nymphs need a pH range between 6.5-7.5. Bass and Crappie would also die; they need a pH between 6-8.5. Remember, most organisms need neutral pH.

Look back at the pH chart. What organism can live in the largest range of pH? What is the pH range? What other types of organisms also have a large pH range? What is the range?

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____

Student Reader, pH

Reading the chart, you should see that bacteria can survive in a pH range from 1-13. This is a huge range - bacteria are very hearty organisms! Plants can live in a pH range between about 6-12 or 13.

Credit: Ann M. Novak

What *causes* pH to become acidic or basic?

People use products on land and do various activities outside that can end up causing a stream to change its pH. How can this happen? If someone puts fertilizer on their lawn, when it rains, the fertilizer can get picked up with the rain and then be carried by the rain downhill into the nearest water. If someone has a car wash, the car wash soap will run downhill and into a storm drain. Did you know that storm drains are connected underground to pipes that flow directly into streams, rivers and lakes? LOTS of people use fertilizer and wash their cars.

People use lots of other of products outside: soaps, windshield wiper fluid, antifreeze. We wash our driveways with a garden hose using tap water or we water our lawns with a sprinkler system. Tap water is water that is treated with chemicals to make it safe for people to drink. Those chemicals in tap water, along with products people use outside on the land can have an acidic or basic pH. If they run-off the land, either through storm drains or downhill on land, they can enter various waterways and change the pH. This can happen even if we live far away from a body of water. Many farmers also use fertilizer and pesticides that can run off into water. So do many people who take care of golf courses. Acid rain can also change the pH of water. Pollution from automobiles and coal-burning power plants can enter the air and interact with moisture and oxygen to form acid rain. The acid rain can enter the streams and lake and change the pH to be more acidic. All of these, use of fertilizer, car washes, and acid rain, and lots of other activities people do outside can cause the pH of freshwater to become either acidic or basic.

Water Quality Standards

Remember earlier we said 6.5-7.5 pH range is excellent and that just below or just above these numbers in the neutral zone are good? A group of scientists got together and developed National Water Quality Standards for freshwater lakes, rivers, and streams (Stapp, & Mitchell, 1995). They used four categories for all water quality test results. They are *excellent, good,* fair, *or* poor. If a water quality test falls into the *excellent* or *good* range for water quality standards, the stream is considered healthy for freshwater organisms with *excellent* being better than *good*. If, on the other hand, the test results match up with *fair* or *poor* water quality, the stream has problems related to supporting freshwater organisms with *poor* being the most problematic.

Here are the pH water quality standards:

pH Water Quality Standards	**pH Range**
Excellent - neutral	6.5-7.5
Good - neutral zone	6.0-6.4 or 7.6-8.6
Fair - too acidic/basic	5.5-5.9 or 8.1-8.0
Poor - too acidic/basic	below 5.5 or above 8.5

When you test your stream or river for pH, what results are you hoping to get? Can you explain why? Include two or three examples of organisms and pH ranges they need in your response?

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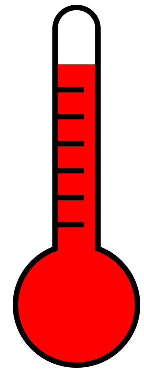
Is the stream too warm for freshwater organisms?
Temperature as a measure of Water Quality



Why do we measure temperature of streams?

We are all familiar with temperature. Temperature tells us how hot or cold something is. The temperature of a stream or river can change. If you live in a northern climate, the water's temperature will be different in the summer than it will be in the winter - that's normal. At the same time of year, the temperature of rivers and streams in the south, like in Florida or Texas, will be different than temperatures in rivers and streams in the north, like in Michigan or Alaska - that's normal too. Climate or the seasons naturally affect the temperature of the water. When we measure for temperature we are trying to determine if the temperature is **abnormally warm** - we're looking for an abnormal temperature increase. For example, we would expect the temperature of waters in Canada to be cool in the winter. If we measure temperature of a river and find it to be hot we would be surprised. We might think, "something isn't right here" and need to investigate further. An abnormal temperature increase is called **thermal pollution**. It is a very different type of pollution than what we usually think of, because it isn't "stuff" that got into the water causing it to be polluted.

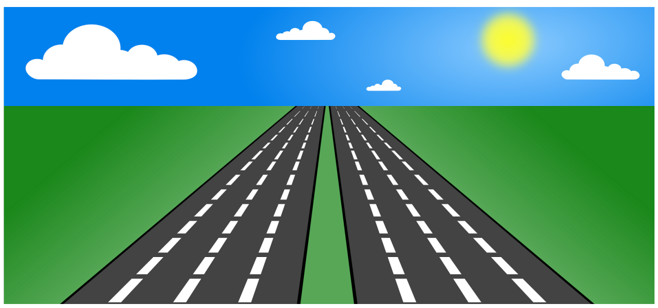
How do we measure for thermal pollution?

When experts test for thermal pollution, they take a temperature reading at two different locations one mile apart and then subtract to obtain a temperature difference. They look to water quality standards for temperature differences to see if there is thermal pollution.
Here are the water quality standards for temperature differences, or thermal pollution:

Thermal pollution Water Quality Standards	**Temperature differences degrees Celsius**
Excellent - no thermal pollution	0-2^0 Celsius change (difference)
Good - no thermal pollution	2.1-5^0 Celsius change (difference)
Fair - thermal pollution	5.1-10^0 Celsius change (difference)
Poor - thermal pollution	above 10^0 Celsius change (difference)

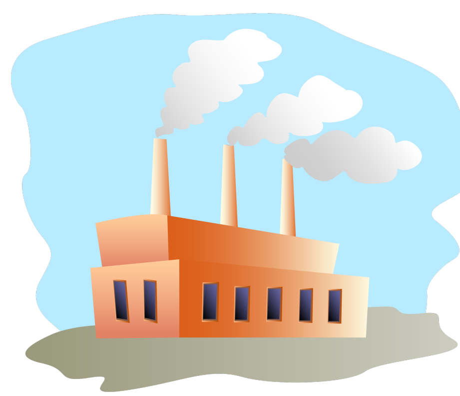
What are the causes of Thermal Pollution?

Think about this: It's a hot summer day and you want to go swimming. You throw on your suit, grab a towel, and jump into your car and an adult takes you to the pool. You were in such a hurry that you didn't put anything on your feet. You arrive to the pool and pull into the parking lot and park. You leap from the car and, "Ouch! Ouch! Ouch!" Your feet are burning up because the parking lot is SO hot! You rush to the grass and "whew! - that feels so much better!" - the grass feels cool.



There are four causes of thermal pollution. One cause of thermal pollution is **hot surfaces**. Human-made parking lots, roads, even rooftops heat up when it's hot outside. If it rains, the rainwater hits these hot surfaces. The rainwater now also becomes hot. Do you remember where rainwater goes? It goes downhill to the nearest storm drain. Do you also remember where the water in storm drains go? It flows into nearby creeks, streams, rivers and lakes. This now **hot** rainwater then flows into the water and heats it up, causing thermal pollution, an abnormal temperature increase.

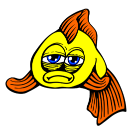
A second cause of thermal pollution is from factories that produce products we use every day, other industries, and power plants. They pull in water from a river or lake and use it to cool their machinery. The water warms up as it cools the hot machines. If this hot water is then discharged back into the river or lake then it warms up, causing thermal pollution.



A third cause of thermal pollution is soil erosion or other particles that are in the stream. Erosion can be caused when people cut down trees; the roots hold soil in place. It can be caused during construction when people dig holes in the ground and loose dirt is put in piles. Poor farming practices can result in loose dirt. All of this loose dirt can be carried into rivers and streams when it rains causing the water to become muddy (turbid). Dark water captures more heat from the sun and the water heats up. This can be a huge problem in the summer when the sun feels so hot.

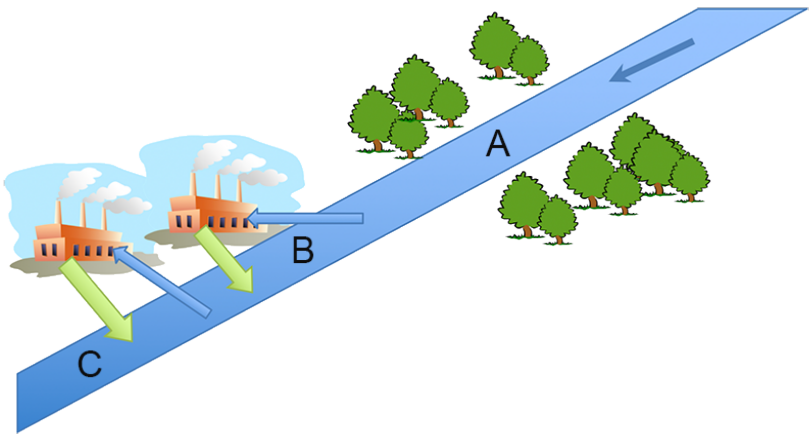
A fourth cause of thermal pollution occurs when people cut down trees along a riverbank or pond. Trees help to shade the river from the sun. Without the trees to provide shade the sun shines directly on the water and it warms up.

What are the effects (consequences) of Thermal Pollution?



Water temperature is very important for the health of a stream or river. There is a negative relationship between thermal pollution and water quality for freshwater organisms. Fish and other aquatic organisms live in certain temperature ranges. If water is too warm they die. For example, trout and stonefly nymphs need cool temperatures. Organisms' dying is one of four consequences of thermal pollution.

A second consequence of thermal pollution is that warm water can promote an algal bloom. Warm water increases the rate of plant growth and plants, like algae, can thrive. When these plants die they are decomposed by bacteria. The bacteria use up the oxygen. Third, warm water cannot hold as much oxygen as cold water so a third consequence of thermal pollution is the potential for less oxygen. Finally, thermal pollution can weaken fish and insects and make them more vulnerable to disease and toxic waste.



1. At Point A of a stream the temperature reading is 11.8 degrees Celsius (°C). At Point B, father down the stream, the temperature reading is 12.8°C. What can you say about the water quality at Point B based on the temperature test? How do you know? What might be the reason for these results? Show all of your work.

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2. At Point B of a stream the temperature reading is 12. °C. At Point C, farther down the stream the temperature reading is 20. °C. What can you say about the water quality at Point C based on the temperature test? How do you know? What might be the reason for these results? Show all of your work.

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Are there too many floating particles in the stream?
Turbidity as a measure of Water Quality

What is turbidity and why is it important?

Did you ever see water that was so dirty that you couldn't see through it? Turbidity measures the amount of floating particles in water that cause the water to look murky. Floating particles, whether on top of the water, throughout the water, or sitting on the waterbed, do not dissolve. Water that is not turbid is clear. High turbidity in freshwater lakes, rivers, and streams means poor water quality.

What causes high turbidity?

There are many different types of particles that float in water. Dirt is a very common cause of high turbidity. Dirt in the water can be the result of two different activities that people do on land. One, when people build houses, apartments, or other buildings, part of the building process often includes digging a hole for a basement or for underground parking. Mounds of dirt can sit at a construction site.

When it rains, the rainwater can pick up the dirt and carry it downhill into streams, rivers, or lakes, or it can first go to storm drains that have pipes that are connected to these waterways. Preventing stormwater pollution is a component of the Clean Water Act (http://www.epa.gov/region5/water/cwa.htm) passed in the United States in 1972. Do you have any ideas of how this dirt run-off might be prevented?

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Did you ever see two-foot fences around a construction site? These silt fences are one solution that the construction industry came up with to help ensure that dirt would not run off from construction areas. The solid mini fences capture dirt by acting as a barrier. They work to prevent dirt runoff.

A second source of dirt is from erosion. Plants have roots that hold the soil in place. If people cut down trees or other plants the result can be loose soil. Just like from construction sites, loose dirt anywhere can be picked up by rain and carried downhill into waterways. Have you ever seen how rivers turn brown after a heavy rain? One solution to erosion is to make sure to plant grass or other plants that will hold soil in place.

There are many other particles that float in the water besides dirt. Organic waste – dead leaves or plants, animal waste from pets and dairy farms carried by runoff, and algae or other tiny plants are examples. Human waste, either from leaking septic tanks or from discharge from wastewater treatment plants, can contribute to turbidity. Floating particles also come from urban runoff including car oil, litter, etc., and from industrial waste.

Look back through the causes of turbidity and identify which ones are the result of people, and which ones are from nature?

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What are the consequences of high turbidity?

Why is high turbidity a problem? There are four consequences to the water quality of a stream if it has high turbidity. First, floating particles in the water absorb heat. This can lead to thermal pollution. Remember learning about thermal pollution in Lesson 4?
Thermal pollution can kill fish. It can also promote algal blooms. And remember, warm water cannot hold as much oxygen as cold water. Floating particles also block sunlight. Plants need the sun to photosynthesize. That means that water plants cannot undergo photosynthesis so plant

growth can then be limited. This is a second consequence of high turbidity. A third consequence of high turbidity is that floating particles can clog fish gills. Can you imagine trying to breathe when the air is full of particles? Perhaps you have been some place where there is lots of smog and it was hard to breathe. Fish don't breathe with lungs; they use gills. The final consequence of high turbidity is that particles can sink and kill fish and insect eggs that are on the bottom.

Water quality standards

There are several different ways to measure turbidity. Depending on the method your class decides to use, there are also different units. Can you identify the method that you will use? Put an "X" over the column to identify the method and units.

Here are the water quality standards for Turbidity:

Turbidity Water Quality Standards	**Turbidity probes NTU's:**	**Secchi disk or Turbidity Tube**	**Engineered filtration system**
Excellent – no (or very little) turbidity, not too many floating particles	0-10	> 3 feet > 91.5 cm	1 = none or very little turbidity
Good – low turbidity	10.1-40	1 foot to 3 feet 30.5 cm to 91.5 cm	2 = low turbidity
Fair – Medium turbidity, too many floating particles	40.1-150	2 in to 1 foot 5 cm to 30.5 cm	3 = medium turbidity
Poor – high turbidity, too many floating particles	> 150	< 2 in < 5 cm	4 = high turbidity

Are there some action steps that you can think of that people can take to minimize the amount of floating solids that may enter waterways?

Table of Water Quality Standards

Water Quality	pH	Temperature Change	Conductivity	Dissolved Oxygen	Turbidity
Excellent	6.5-7.5	0-2 °Celsius	Less than 100 mg/L	Less than 50%	None (1)
Good	6.0-6.4 7.6-8.0	2.1-5.0 °C	100-250 mg/L	51-70%	Low (2)
Fair	5.5-5.9 8.1-8.5	5.1-9.9 °C	250-400 mg/L	71-90%	Medium (3)
Poor	Less than 5.5 Greater than 8.6	10 °C and above	Over 400 mg/L	91-110%	High (4)