Pollution P.I.

Adapted from: "Pollution P.I" in Environmental Resource Guide: Nonpoint Source Pollution Prevention Grades 9-12. Tennessee Valley Authority and Air and Waste Management Association, 1993.

Grade Level: Intermediate to Advanced

Duration: two 45-minute periods

Setting: classroom

Summary: Students interpret water quality data and land use impacts on water quality to match water quality data with its location on a map.

Objectives: Students will use chemical data to determine the extent of nonpoint source pollution, linking chemical tests to the problems they can detect.

Vocabulary: water pollution, point source, nonpoint source, eutrophication, sediment, sedimentation, riparian, bioaccumulation, Best Management Practices

Related Module Resources:
- Land Use Impacts on Water Quality Parameters (teachers *only* document)

Materials (Included in Module):
- Pollution P.I. Module Activity Envelope with materials
- Anywhere USA map for students
- Pollution P.I. Worksheet and Answer Key
- Anywhere USA Map
- Data Table
- Data Table Key
- Anywhere USA Colored-Coded Map Key
- Clue cards originals for making your own game pieces
- Wet erase marker

Additional Materials (NOT Included in Module):
- Projecting unit

Academic Standards:

Ecology & Environment

7th Grade

4.1.7.B Understand the role of the watershed.
- Explain factors that affect water quality and flow through a watershed

4.3.7.A Identify environmental health issues.
- Identify various examples of long-term pollution and explain their effects on environmental health.

4.3.7.B Describe how human actions affect the health of the environment.
- Identify land use practices and their relation to environmental health.
- Explain how nonpoint source pollution can affect the water supply and air quality.
- Explain how acid deposition can affect water, soil and air quality.

10th Grade

4.3.10.A Describe environmental health issues.
- Identify the effects on human health of air, water and soil pollution and the possible economic costs to society.

4.3.10.B Explain how multiple variables determine the effects of pollution on environmental health, natural processes and human practices
- Explain how human practices affect the quality of the water and soil.

12th Grade

4.1.12.C Analyze the parameters of a watershed.
- Interpret physical, chemical and biological data as a means of assessing the environmental quality of a watershed.
- Apply appropriate techniques in the analysis of a watershed (e.g., water quality, biological diversity, erosion, sedimentation).

4.3.12.C Analyze the need for a healthy environment.
- Explain how human systems affect the environment

BACKGROUND:

Water is a vital resource because it is necessary for so many things, but pollution limits its value and usefulness. **Water pollution** is an undesirable change in the physical, chemical, or biological characteristics of a body of water that can negatively affect the health, survival, or activities of humans and other living organisms. Much attention has been given to studying sources of pollution, and finding ways to prevent and treat water pollution.

Often, pollution is classified into two categories: **point source** and **nonpoint source** pollution. Point source pollution is a single, identifiable source that discharges (empties) pollutants into the environment. Examples would include a leaking waste storage container and a drainage pipe from a sewage treatment plant, industry, or off a city street. The cause of nonpoint source pollution (NPS) is more difficult to pinpoint because this pollution type can enter a stream with runoff from a widespread land area. Examples include farm fields, large construction sites, mining operations, lawns, and parking lots. To help distinguish the difference, think of point source pollution as pollution that could be stopped if a cap or seal were placed over the discharge source or small barrier were built around the source before entering the stream. In contrast, to stop NPS, you would need to build a long cement barrier that would border the stream above and below ground and catch runoff from the adjacent land.

All land uses contribute to NPS in some way. Major sources include improper land use practices in agriculture, forestry and mining, inadequate control of growth and development in cities, and storm sewers. Pollutants from these land uses include nitrates and phosphates from excess fertilizers, sediment from improperly managed construction sites, crop and forest lands, mining operations, and eroding stream banks, salts from de-icing practices, acid drainage from abandoned mines, and bacteria and nutrients from livestock, pet wastes, and faulty septic systems.

Nitrates and phosphates that are discharged directly into waterways or wash into waterways in runoff are problematic because they spark explosive plant growth. Eventually the plants die and are decomposed by oxygen consuming decomposers. As a result of this process called **eutrophication**, the waterway is depleted of oxygen. With insufficient oxygen, aquatic life slows its metabolism or even die.

Soil erosion causes nonpoint pollution by adding silt and sand (called **sediment**) to a body of water, such as a river. Sediment is the single largest nonpoint source pollutant. Sediment increases turbidity and water temperature, which reduces dissolved oxygen levels. When sediment settles out of the water in the process of **sedimentation**, it also smothers habitat and amphibian and fish eggs. In addition, sediment particles also carry many other pollutants such as chemicals and nutrients (such as nitrates and phosphates) into water bodies. Land use practices greatly affect how much sediment is washed into water bodies. Any land use that removes riparian (streamside) vegetation, increases the amount of sediment entering waterways. Intact riparian buffers, however, protect waterways by absorbing and blocking sediment and runoff, and by sequestering the nutrients in runoff while also providing habitat and food for organisms.

Water pollution can have profound effects on humans, other organisms, the environment, and the economy. Below are some of the ways in which different land use practices can contribute to water pollution:

<u>Agriculture (crops)</u> – Poor farming practices or farming highly erodible lands can cause severe erosion. Excess fertilizer washes into lakes, bays and rivers and adds phosphates and nitrates to the water. These extra nutrients cause excessive growth of algae and underwater weeds and eventually eutrophication. Pesticides can have long-term effects on wildlife and human health by accumulating in the food chain (**bioaccumulation**). **Best Management Practices** (BMPs) are farming practices that farmers are encouraged to adopt in order to reduce the negative impacts of their land use on water quality and the environment in general.

Agriculture (animal husbandry) – Overgrazing , particularly in the western United States, and poorly managed livestock operations can both accelerate sediment loading of water bodies. Livestock grazing on streambanks can severely erode these banks, causing tons of soil to wash into waterways. Excrement from livestock that defecate directly into the waterway or excrement that washes into waterways add nutrients to the waterways and eventually result in eutrophication.

Mining – Acid mine drainage from strip mining and deep shaft mining can both cause water quality problems. Acid mine drainage drastically reduces the pH of waterways to levels that can support little, if any, aquatic life. The lower pH also releases into the waterway metals normally locked up in rocks and sediment. These metals also adversely affect aquatic life. The construction of temporary roads to remove minerals can also cause erosion.

Urban areas – Storm water runoff containing road salt, soil, lawn and garden chemicals, and pet wastes can travel via street and storm drains to nearby rivers, lakes and estuaries and degrade drinking water supplies, recreational areas, and wildlife habitat. Household and automotive products like oil, grease, gasoline, paints, fertilizers, pesticides, and other household chemicals carelessly disposed of in backyards, on streets, and in storm sewers can end up in our surface waters. These substances can harm aquatic life, degrade water supplies, and, in severe case, fish consumption may be banned to protect public health.

Construction – Tree and vegetation removal as well as temporary roads at construction sites increase soil erosion. The additional sediment eroded from these sites is eventually carried to waterways in runoff, which picks up nutrients and other contaminants along the way. The lack of trees at many streamside construction sites leads to increased water temperatures due to the absence of or sparse shade.

Industry - Industries use numerous chemicals and toxins in their manufacturing processes. Although the Department of Environmental Protection Regional Offices monitor and regulate what these industries can discharge, some pollutants still enter waterways. Steel mills, for example, often discharge water used to cool equipment into waterways. The warm or even hot water drastically changes the temperature of streams. Other substances sometimes discharged by steel mills include metals, acids, oil, cyanide, and phenols, a type of poisonous acid. All of these toxins have adverse effects on aquatic life and drinking water quality. Most industries also contribute to water pollution indirectly through the air pollution. The compounds pumped out of billowing industry smoke stacks cause acid rain, which eventually falls or flows into waterways, increasing their acidity.

Deforestation - As described above, any activity that removes vegetative cover from the land increase erosion. The destruction of streamside (riparian) vegetation is particularly problematic because these buffers protect waterways by absorbing and blocking sediment and runoff, and by sequestering the nutrients in runoff while also providing habitat and food for organisms.

OVERVIEW:

Students use clues about water quality and their knowledge of the connections between different land uses and water pollution to determine the location of mystery collection stations on a map.

PROCEDURE:

Teacher Preparation:

1. Locate the Pollution P.I. activity materials in the module. These include 12 medium envelopes (Kline Collection Station Envelope A, Kline Collection Station Envelope B, Harrison Collection Station Envelope C, Harrison Collection Station Envelope D, Cody Collection Station Envelope E, Moby Collection Station F, Moby Collection Station G, Cody Collection Station H, NERAK Collection Station I, NERAK Collection Station J, Stows Collection Station K, Stows Collection Station L), each containing 6 small envelopes. Each small envelope contains numerous "clue cards." The small envelopes within a given medium envelope are identical, as are the clue cards in them. There are several copies of the small envelopes so that multiple student groups can be working with the same sets of clues simultaneously.

2. Locate and photocopy the "Anywhere USA" Map and Pollution P.I. worksheets for your students. Anywhere USA map, the Pollution P.I Answer Key, the Color-Coded Anywhere USA Map Key, and the wet erase marker in the module binder.

3. Procure and set up an overhead projector.

Student Activity:

1. Stimulate a discussion with your students about the different land uses in your community and brainstorm how these land uses might affect water quality.

2. Divide the class into teams of three or four.

3. Distribute the "Anywhere USA" maps and worksheets.

4. Refer to #1 on the student worksheet. Display the "Anywhere USA" overhead. Explain to the students that water quality in the Broad River was tested by taking samples at the six stations listed on the map. Water was sampled at several sites across the width of the river and at different depths at each collection station.

5. Refer to #2-4 on the student worksheet. Ask the students which way the river is flowing. (The headwaters is the area where the river starts. Water flows from the headwaters downstream - to station #1, then #2, and so on to station #6.) Make sure the students understand that water collected at Station 1 would represent water upstream from the site. Water collected at Station 2 would represent water coming into the river between Station 2 and Station 1, and would also include water upstream from Station 1.

6. Refer to #5 and 6 on the student worksheet.

7. Refer to #7 on the student worksheet. Explain that you will be distributing envelopes to the different student teams. Each envelope contains clue cards with important data for each site. Each team is only permitted to have two envelopes at any given time. Students should record the data on the clue cards in data table on their worksheet. The more information students have, the easier it will be to identify the collection site. If necessary, you might want to run through one envelope of cards with the whole class. Use the data table overhead transparency to do so. Have students record this information on their data sheets as well. Explain that their objective is to match all the collection site names to those listed on the map by number based on the information revealed on the clue cards and their knowledge of how different land uses affect water quality.

8. Give each team two envelopes with a station name clearly marked on the front and have them use the clue card information to fill in their data sheets.

9. Explain that when the teams finish with one envelope, they should exchange it with you for another. Remind students that each team is only permitted to have two envelopes at any given time. Explain that time is always a factor in any investigation and they may not have all the time they need to complete their investigation. Tell the students to just do the best they can. Each team needs data on all six collection sites, so encourage them to do as many envelopes as possible given the time constraints.

10. Refer to #8 on the student worksheet. When a team thinks they have collected sufficient information to match the collection station names to the collection station numbers on the Anywhere USA map, have them fill in their answers in question #8. Have them consult with the instructor to check their work.

11. Allow students sufficient time to work with the clue cards to collect information about the various collection stations.

12. Refer to #9 on the student worksheet. When the teams have discovered the correct answers, they should brainstorm within their group to determine the possible pollution sources. They should also come up with strategies for reducing the pollution from those sources.

13. Discuss the answers when everyone has finished. What are the problems? What are some possible solutions? Ask the students where on the map they would want to live and why.

14. Refer to #10 on the student worksheet. Have students examine the table and determine which water type (1,2, 3 or 4) corresponds to excellent, good, fair, and poor water quality. See answers in the chart below. Next, explain that site maps are often color coded to focus on specific problem areas. These maps are often used to plan corrective actions. Distribute colored pencils or crayons and have the students color code the maps using the chart below:

If desired, have each person on a team select one variable to color code on his or her map of Anywhere USA. For example, have one person color code only temperature on their map; another would color code only sulfates, and a third only pH. Make sure that students also include a key on their map(s). Use the Anywhere USA map overhead and colored wet or dry erase markers to show students an example of how to color-code the waterway. Also, you may want to have students use colored symbols to indicate agricultural, industrial, and municipal areas on the map. Have students add these symbols to the key. Use the color-coded key transparency to go over the correct color-coding with your students.

15. Refer to #11 on the student worksheet. If possible and appropriate, have the students complete the optional essay, either during class time or as an out-of-class assignment.

DISCUSSION:

What is the difference between point and non-point source pollution? *See background section.*

Why are moderate pH levels, low sediment loads and low levels of coliform bacteria important in waterways? *pH levels around 7 (neutral) or slightly greater than 7 (basic) are ideal for most forms of aquatic life. More acidic pH levels cannot support as much biodiversity. See background for problems associated with sediment. Coliform bacteria has been linked with serious health problems in both humans and wildlife.*

How do different land uses affect water quality, aquatic life, and humans? *See background section.*

How do the activities of people upstream affect water quality and people downstream? *"We all live downstream." We are all affected by the activities and land uses upstream. Pollutants entering waterways upstream do not disappear. They flow downstream and affect the people and aquatic life there. See the background section for details on how different land uses affect water quality.*

How could you use your color-coded maps to plan strategies to address nonpoint source pollution problems? *Answers will vary but, as with Geographic Information Systems maps, which layer information, the students' color-coded maps will help them correlate different land uses and the effects they have on water quality. Once they have identified the sources of water pollution on the maps, they can investigate ways to reduce the impacts of the land uses responsible for the water pollution.*

What activities and/or land uses in your community might be impacting water quality, aquatic life, and people downstream? *Answers will vary.*

What actions might you take to help reduce the negative impacts of these land uses on your downstream neighbors? *Implementing Best Management Practices (BMPs),* *restoring riparian buffers by planting trees and cover vegetation, fencing cows out of waterways, etc.*

What activities and/or land uses occurring upstream of your community might be affecting water quality, aquatic life, and people right here in your community? *Answers will vary.*

How might you work with upstream communities to reduce the impacts of their practices on water quality, aquatic life, and humans in your community? *Answers will vary but ideas include organizing watershed groups that work to improve water quality in the watershed as a whole, not just in specific municipalities, a pen-pal program with classes at other schools upstream to open up dialogue about the issue, student research upstream and downstream and then a student research symposium to share the students' findings and strategize solutions, etc.*

EVALUATION:

- Identify what type of chemicals might be detected in water bodies based on land use.
- Identify land use patterns based on the quality of water in neighboring water bodies.
- Identify what types of water quality parameters you would test to identify different types of pollution.
- Distinguish between point and nonpoint source pollution. Give examples of both.

EXTENSIONS AND MODIFICATIONS:

- Divide the students into groups, have them gather similar data at six different sites, make their own clue cards, and develop their own Pollution P.I. game.
- Test water parameters at a number of sites - upstream to downstream. Look to see if there are trends in these parameters. Discuss what land uses caused these trends.
- Based on the answers and ideas students give for the last discussion question above, pursue one or more of these ideas with your students.

NOTES (PLEASE WRITE ANY SUGGESTIONS YOU HAVE FOR TEACHERS USING THIS ACTIVITY IN THE FUTURE):

MAP: POLLUTION P.I. – ANYWHERE USA

Name____Date______________

Map Source: "Pollution P.I" in *Environmental Resource Guide: Nonpoint Source Pollution Prevention Grades 9-12. Tennessee Valley Authority and Air and Waste Management Association, 1993.*

WORKSHEET: POLLUTION P.I.

Name____Date______________

1. Examine the map of "Anywhere USA".

2. What direction(s) does the Broad River flow?

   ____

3. How many water collection stations are located on the Broad River?

   ____

4. If someone washed their dirty socks at Station #4 and all the dirt and smell entered the water, why would a student sampling at Station #1 not detect the pollution from the dirty socks?

   ____
   ____
   ____

5. What land use impact(s) would be detected by Station #1?

   ____
   ____
   ____
   ____

6. What land use impact(s) would be detected by Station #4?

   ____
   ____
   ____
   ____

7. Water samples were taken from several sites across the width of the Broad River and at different depths at each collection site. Your teacher will give you envelopes with clue cards describing the results of these tests. Your teacher will instruct you on how many envelopes there are to use and how to swap them to get new envelopes. Use the information on the clue cards to fill in the data table on the next page. Summarize what the clue card says in the data table by indicating if levels were high, low, medium, none, what the numbers were, or if no information was provided.

Data Table: Pollution P.I.

	STOWS STATION	KLINE STATION	CODY STATION	NERAK STATION	HARRISON STATION	MOBY STATION
Temperature						
pH						
Sediment Load						
Toxic Chemicals						
Coliform Bacteria						
Fertilizers						
Pesticides						
Salts (Chlorides, Sulfides, Sulfates)						
Metals						
Other debris at site						

8. Based on the information in the data table above and the Anywhere USA map, which station number corresponds to which station?

   Stows Collections Station = Station # ____

   Kline Collection Station = Station # ____

   Cody Collection Station = Station # ____

   NERAK Collection Station = Station # ____

   Harrison Collection Station = Station # ____

   Moby Collection Station = Station # ____

9. Identify the possible pollution sources for each collection station and potential strategies to reduce that pollution.

Station	Pollution Sources	Strategies to Reduce the Pollution
Station #1		
Station #2		
Station #3		
Station #4		
Station #5		
Station #6		

10. a)Examine the chart below. Based on the temperature, sulfates, and pH levels and your knowledge of the effects of these levels on aquatic life, determine which water type (1,2,3 or 4) corresponds to excellent, good, fair, or poor water quality and fill in the blanks in the chart.

    b) Site maps may be color-coded to illustrate specific land use problem areas. These maps are often used to plan corrective actions. On your Anywhere USA map, color the river or directly above or below the river according to the chart below and based on the information you gathered from the clue cards. For example, if the temperature of the water is between 73 and 79 ^{o}F at a given collection station #5, color the area above the river between station #4 and station #5. Make a key on your map to indicate what the different colors mean. Either color in groups or individually – your teacher will instruct you.

Water Type (label as excellent, good, fair, or poor)	**Color**	**pH** ***(color in the river)***	**Sediment Load** ***(color above the river)***	**Coliform Bacteria** ***(color below the river)***
1. ________________________ water quality	Blue	7.1-7.5	0-5 times higher	Very Low
2. ________________________ water quality	Green	6.6-7.0	10 times higher	Acceptable
3. ________________________ water quality	Yellow	6.1-6.5	100 times higher	Medium
4. ________________________ water quality	Red	5.5-6.0	500 times higher	High

Optional Essay

11. On a separate sheet of paper, offer suggestions for correcting or reducing the effects of some of the pollution sources in Anywhere USA. Was there a specific land use that you thought was most detrimental to the Broad River? Why or why not?

KEY: POLLUTION P.I.

1. Examine the map of “Anywhere USA”.

2. What direction(s) does the Broad River flow?
The Broad River flows from east to west.

3. How many water collection stations are located on the Broad River?
There are 6 stations.

4. If someone washed their dirty socks at Station #4 and all the dirt and smell entered the water, why would a student sampling at Station #1 not detect the pollution from the dirty socks?
The student at Station #1 would not detect pollution from the dirty socks because he/she is upstream of Station #4. Only stations downstream of Station #4 (i.e., Stations #5 and #6) would detect the sock pollution.

5. What land use impact(s) would be detected by Station #1?
Cattle grazing/animal husbandry impacts from Stampede Valley and potentially effects from the town of Jonesboro.

6. What land use impact(s) would be detected by Station #4?
Cattle grazing/animal husbandry impacts from Stampede Valley, potentially effects from the town of Jonesboro, urbanization impacts from Auto City, potentially effects from Boomtown, and mining impacts from Copper Mountain,

7. Water samples were taken from several sites across the width of the Broad River and at different depths at each collection site. Your teacher will give you envelopes with clue cards describing the results of these tests. Your teacher will instruct you on how many envelopes there are to use and how to swap them to get new envelopes. Use the information on the clue cards to fill in the data table on the next page. Summarize what the clue card says in the data table by indicating if levels were high, low, medium, none, what the numbers were, or if no information was provided.

Data Table: Pollution P.I.

	STOWS STATION	KLINE STATION	CODY STATION	NERAK STATION	HARRISON STATION	MOBY STATION
Temperature	*80-86 F (27-30C)*	*73-79 F (23-26C)*	*80-86 F (27-30C)*	*94-100F (35-38C)*	*73-79F (23-26C)*	*80-89F (27-30C)*
pH	*6.4 (acidic)*	*7.1-7.5 (slightly basic)*	*5.9 (most acidic)*	*6.1 (acidic)*	*7.1-7.5 (slightly basic)*	*6.6-7.0 (slightly acidic)*
Sediment Load	*100x higher*	*5x higher*	*5x higher*	*500x higher*	*10x higher*	*Lowest*
Toxic Chemicals	*No info.*	*No info.*	*No info.*	*Significant amounts*	*No info.*	*No info.*
Coliform Bacteria	*Acceptable*	*Medium*	*Very low*	*Highest count*	*High*	*Acceptable*
Fertilizers	*Residues (small amounts)*	*No info.*	*No info.*	*Significant amounts*	*No info.*	*No info.*
Pesticides	*Residues (small amounts)*	*Low or trace*	*No info.*	*No info.*	*Medium*	*No info.*
Salts (Chlorides, Sulfides, Sulfates)	*Significant salts*	*Not discovered*	*High sulfates*	*High sulfides*	*Not discovered*	*High chloride and sulfide*
Metals	*No info.*	*Not discovered*	*High iron and other metals*	*High metals*	*Not discovered*	*High iron and other metals*
Other debris at site	*Not discovered*	*Not discovered*	*miscellaneous solids, paper, rags*	*undecomposed organic matter*	*Not discovered*	*miscellaneous solids, paper, rags, plastic*

8. Based on the information in the data table above and the Anywhere USA map, which station number corresponds to which station?

   Stows Collections Station = Station # ***5***

   Kline Collection Station = Station # ***2***

   Cody Collection Station = Station # ***4***

   NERAK Collection Station = Station # ***6***

   Harrison Collection Station = Station # ***1***

   Moby Collection Station = Station # ***3***

9. Identify the possible pollution sources for each collection station potential strategies to reduce that pollution.

Station	Pollution Sources	Strategies to Reduce the Pollution
Station #1	***Animal excrement, erosion, riparian buffer deterioration***	***Answers will vary but may include streambank fencing and riparian restoration***
Station #2	***All pollution sources from Station #1, plus old drainage pipes (possibly containing lead and rust), abandoned structures that may come in contact with the water***	***All strategies from Station #1 plus potentially capping/removing old drainage pips and demolishing and cleaning up abandoned structures***
Station #3	***All pollution sources from Stations #1 and #2, plus oil, gasoline, salts, runoff from roads, pollution from industries***	***All strategies from Stations #1 and #2, plus stricter pollution regulations and compliance on part of industries***
Station #4	***All pollutions sources from Stations #1, #2, and #3, plus mining runoff, high copper and iron content, erosion***	***All strategies from Station #1, #2, and #3, plus possibly reclamation of old strip mines***
Station #5	***All pollution sources from Stations #1, #2, #3, and #4, plus fertilizers, pesticides and erosions***	***All strategies from Station #1, #2, #3, and #4 plus perhaps using Integrated Pest Management in lieu of traditional pesticides and fertilizers***
Station #6	***All pollution sources from Stations #1, #2, #3, #4, and #5, plus erosion, riparian buffer deterioration, oil, gasoline, salts, runoff from roads, pollution from industries***	***All strategies from Stations #1-#5***

10. a)Examine the chart below. Based on the temperature, sulfates, and pH levels and your knowledge of the effects of these levels on aquatic life, determine which water type (1,2,3 or 4) corresponds to excellent, good, fair, or poor water quality and fill in the blanks in the chart. ***See below for answers.***

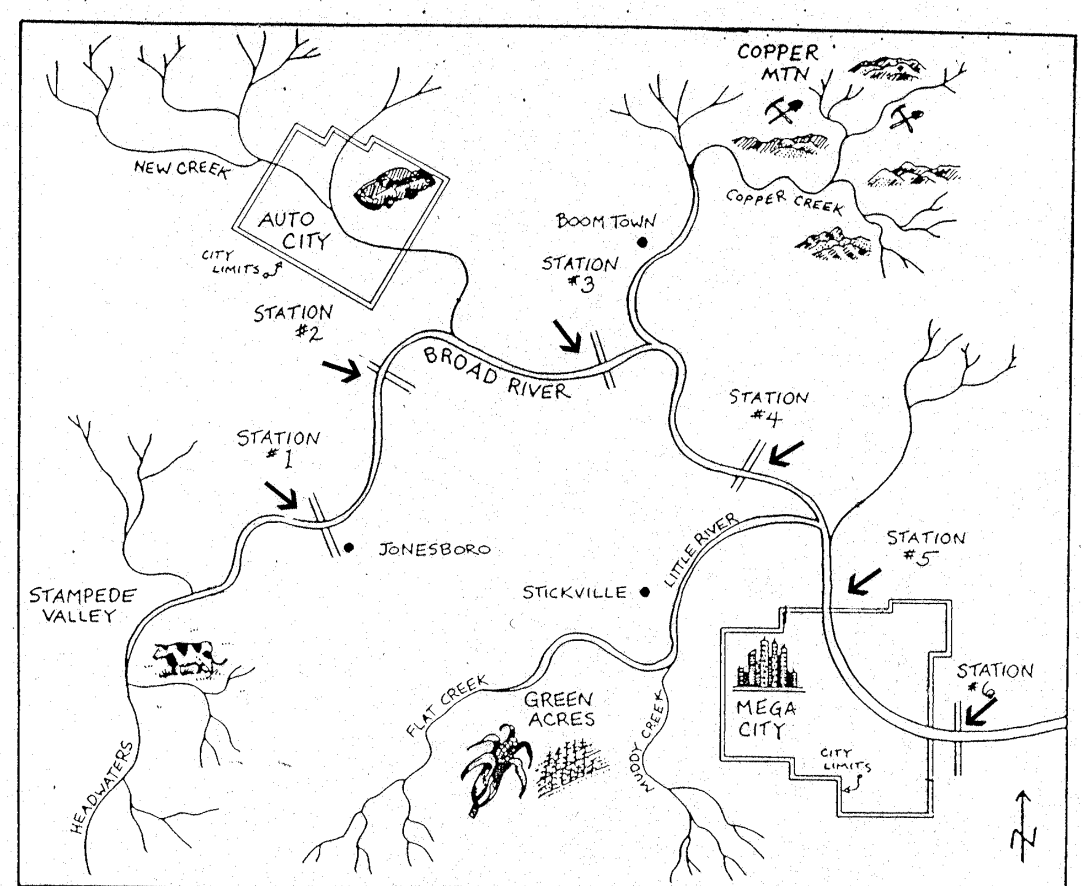
    b) Site maps may be color-coded to illustrate specific land use problem areas. These maps are often used to plan corrective actions. On your Anywhere USA map, color the river or directly above or below the river according to the chart below and based on the information you gathered from the clue cards. Make a key on your map to indicate what the different colors mean. Either color in groups or individually – your teacher will instruct you. ***See color-coded overhead for answers.***

Water Type (label as excellent, good, fair, or poor)	**Color**	**pH** ***(color in the river)***	**Sediment Load** ***(color above the river)***	**Coliform Bacteria** ***(color below the river)***
1. ***Excellent*** water quality	Blue	7.1-7.5	0-5 times higher	Very Low
2. ***Good*** water quality	Green	6.6-7.0	10 times higher	Acceptable
3. ***Fair*** water quality	Yellow	6.1-6.5	100 times higher	Medium
4. ***Poor*** water quality	Red	5.5-6.0	500 times higher	High

Optional Essay

11. On a separate sheet of paper, offer suggestions for correcting or reducing the effects of some of the pollution sources in Anywhere USA. Was there a specific land use that you thought was most detrimental to the Broad River? Why or why not?

ANYWHERE USA



Copper Mountain - Top of a mountainous region to the north that has been extensively mined for copper and iron from Boomtown, up Copper Creek, and along its tributaries.
Stampede Valley - Major cattle ranching district between Cattle Creek and the headwaters of Broad River (due to economic difficulties, range land is overgrazed in some valleys).
Green Acres - Large farming area upriver from Stickville, between Flat Creek and Muddy Creek.
Auto City - Old established city where the majority of the population relies heavily on the auto/steel industry which is the economic base for the city.
Mega City - A new, rapidly growing city with major construction constantly going on, including a wide variety of industry and business.
Jonesboro - Oldest town in state with little or no growth and a small population.

Map Source: "Pollution P.I" in <u>*Environmental Resource Guide: Nonpoint Source Pollution Prevention Grades 9-12*</u>*. Tennessee Valley Authority and Air and Waste Management Association, 1993.*

PROJECT ON BOARD: POLLUTION P.I. DATA TABLE

	STOWS STATION	KLINE STATION	CODY STATION	NERAK STATION	HARRISON STATION	MOBY STATION
Temperature						
pH						
Sediment Load						
Toxic Chemicals						
Coliform Bacteria						
Fertilizers						
Pesticides						
Salts (Chlorides, Sulfides, Sulfates)						
Metals						
Other debris at site						

PROJECT ON BOARD: POLLUTION P.I. DATA TABLE

	STOWS STATION	KLINE STATION	CODY STATION	NERAK STATION	HARRISON STATION	MOBY STATION
Temperature	*80-86 F (27-30C)*	*73-79 F (23-26C)*	*80-86 F (27-30C)*	*94-100F (35-38C)*	*73-79F (23-26C)*	*80-89F (27-30C)*
pH	*6.4 (acidic)*	*7.1-7.5 (slightly basic)*	*5.9 (most acidic)*	*6.1 (acidic)*	*7.1-7.5 (slightly basic)*	*6.6-7.0 (slightly acidic)*
Sediment Load	*100x higher*	*5x higher*	*5x higher*	*500x higher*	*10x higher*	*Lowest*
Toxic Chemicals	*No info.*	*No info.*	*No info.*	*Significant amounts*	*No info.*	*No info.*
Coliform Bacteria	*Acceptable*	*Medium*	*Very low*	*Highest count*	*High*	*Acceptable*
Fertilizers	*Residues (small amounts)*	*No info.*	*No info.*	*Significant amounts*	*No info.*	*No info.*
Pesticides	*Residues (small amounts)*	*Low or trace*	*No info.*	*No info.*	*Medium*	*No info.*
Salts (Chlorides, Sulfides, Sulfates)	*Significant salts*	*Not discovered*	*High sulfates*	*High sulfides*	*Not discovered*	*High chloride and sulfide*
Metals	*No info*	*Not discovered*	*High iron and other metals*	*High metals*	*Not discovered*	*High iron and other metals*
Other debris at site	*Not discovered*	*Not discovered*	*miscellaneous solids, paper, rags*	*undecomposed organic matter*	*Not discovered*	*miscellaneous solids, paper, rags, plastic*