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Water Quality

Virginia Cooperative Extension
Virginia Tech • Virginia State University

This module was developed by Phyllis Turner, PhD, Extension Master Gardener

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Welcome to 'Water Quality'

Read Chapter 17, in your Master Gardener Handbook before viewing these slides.

- Browse the Suggested Readings at the end of these slides. They contain online sources that will be helpful for your learning.
- The Test Your Knowledge section is for fun and review
- When you are ready, take the quiz, you can print out a copy by clicking on "Printable Copy of Quiz" on the first slide to get a copy to work on

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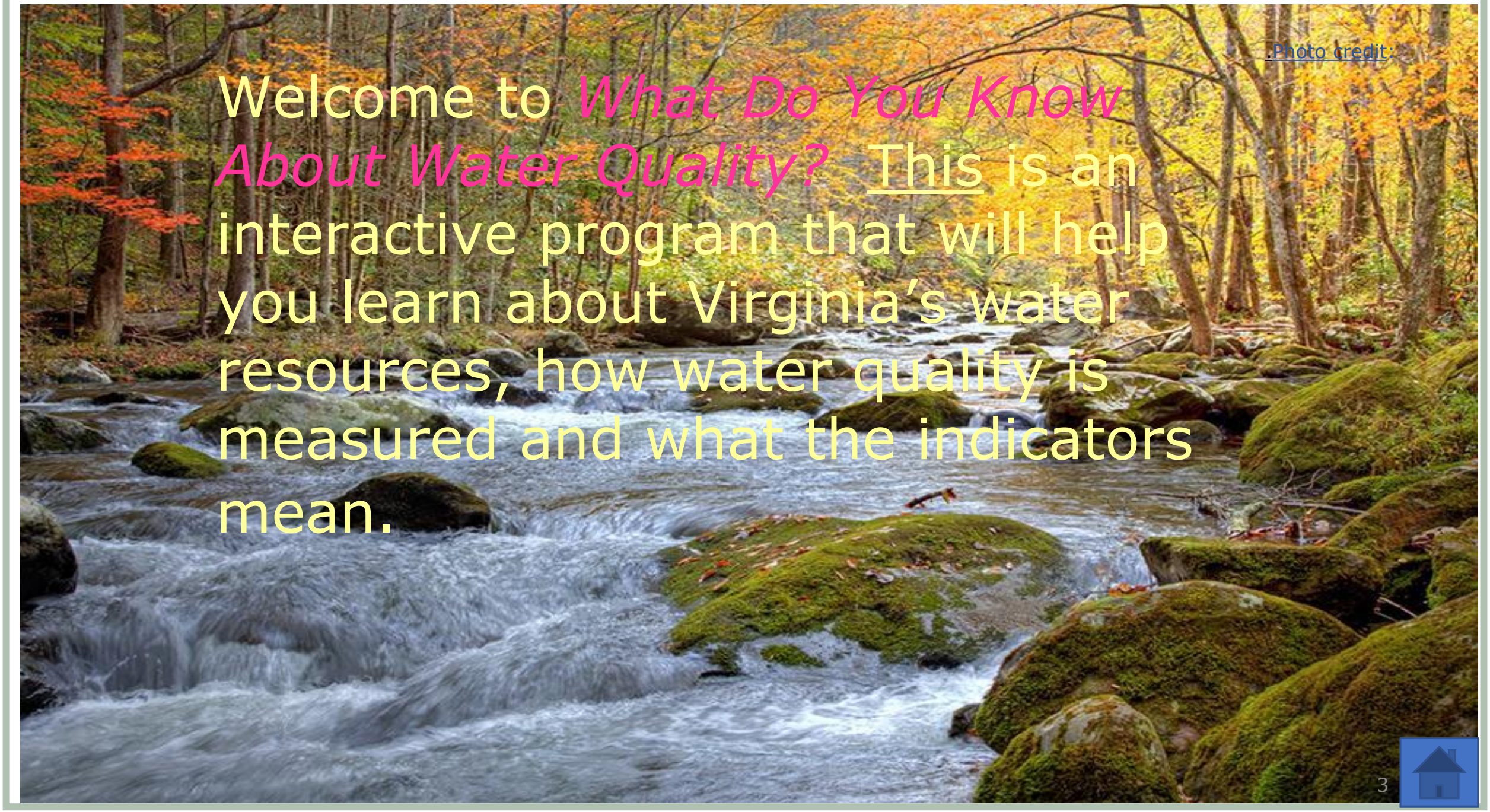

Photo credit:

Welcome to *What Do You Know About Water Quality?* This is an interactive program that will help you learn about Virginia's water resources, how water quality is measured and what the indicators mean.

What I Will Learn in This Module (Objectives)

1. Description of run-off and leaching
2. Point and non-point sources of pollution
3. Water quality indicators
4. Chemical pesticides and their impact on water quality
5. Guidelines for proper management of chemicals used in and around the home to improve the quality of water supply

INTRODUCTION

We all need clean water. We need it not only for personal use, but also for:

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Manufacturing

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Transportation

Photo credit

Wildlife

© Merle Ann Loman

Photo credit

Treating wastes

Photo credit

Food Production

and many other uses.

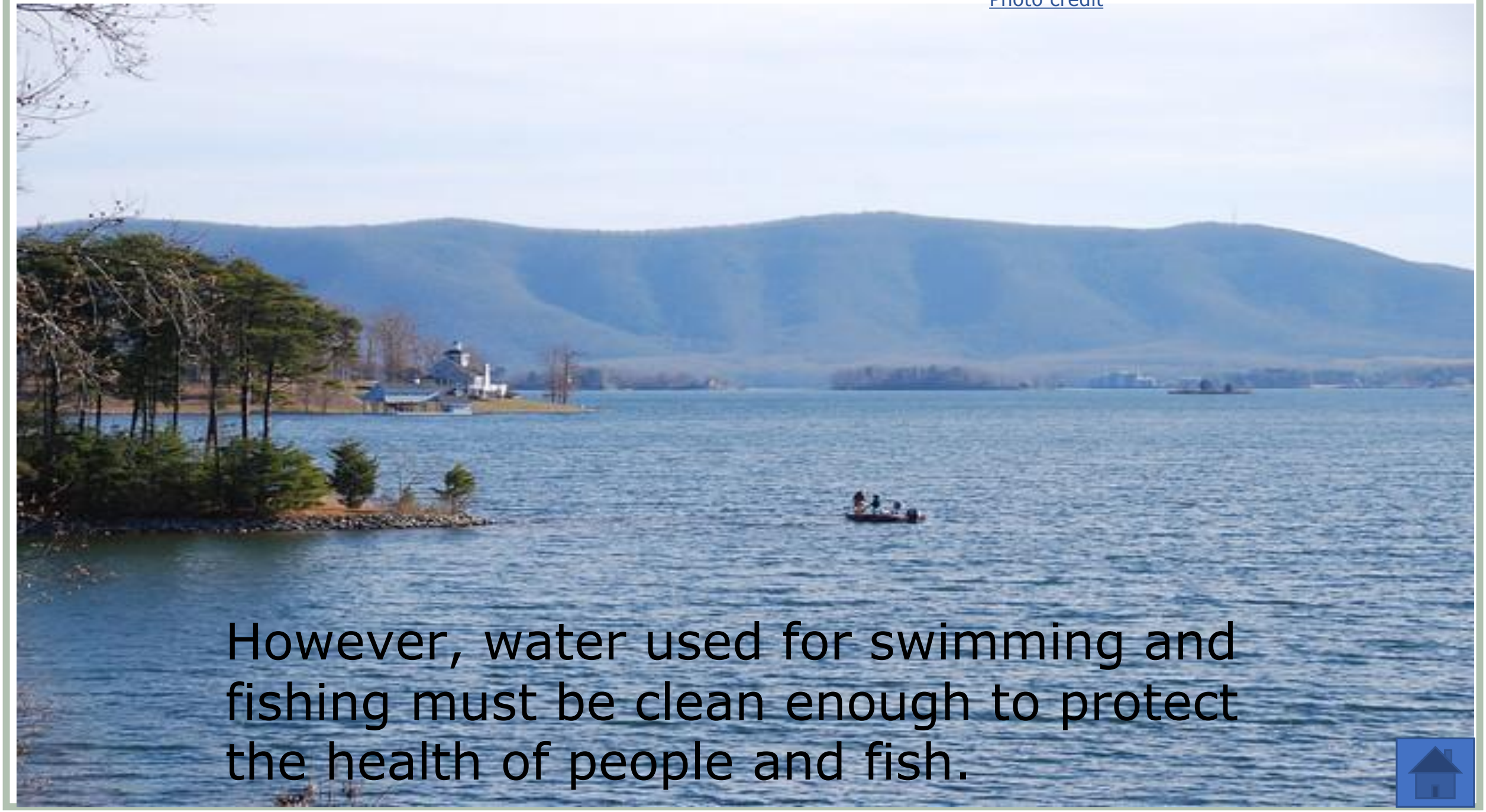
Water quality refers to the condition of the water. How water is used determines what the condition needs to be.

Photo credit

Photo credit

Drinking water must be in better condition (cleaner) than water used for swimming and fishing.

Photo credit



However, water used for swimming and fishing must be clean enough to protect the health of people and fish.

Regardless of how water is used, good water quality is a must. However, nearly everything we do affects the quality of water.

Vehicles, industry and natural events create air-borne particles and gases that enter waterways with dust, rain and snow.

Traffic Northern VA.
Photo credit

Photo credit
Sewage treatment adds nutrients and other pollutants to waterways.
Agriculture and yard care produces sediment, nutrient and pesticide pollution.

Photo credit
Many types of chemicals can enter rivers, lakes and groundwater through improper use and storage.
Motor oil and other automotive chemicals can enter waterways from parking lots and highways.

There are many sources of water pollution. Pollution that originates from a specific place is called POINT SOURCE POLLUTION. This includes outflows from sewage plants, factories, landfills, feed lots and underground storage tanks.

Photo credit

Feedlot Photo credit

Pollution that comes from a wide area is called NON-POINT SOURCE POLLUTION. This includes runoff from parking lots, roads, farms, yards, stream banks, air pollution, and contaminated groundwater.

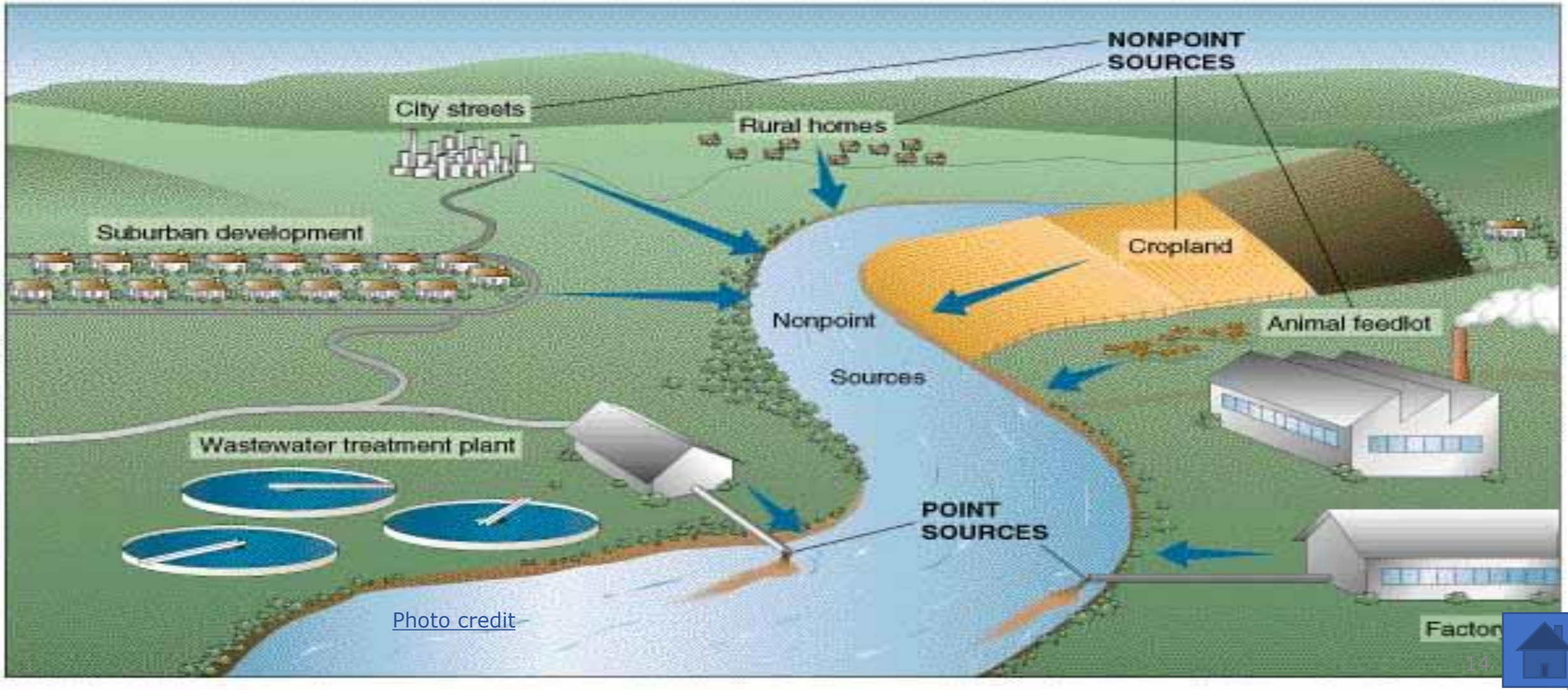


Photo credit

Chesapeake Bay

Photo credit

Water pollution can also originate from natural sources. Mineral-rich soils, natural oil seepage, coastal saltwater, wildlife and natural disasters can all affect water quality.

There are many types of water pollution. Some of these include:

- Petroleum Products
- Nutrients
- Sewage
- Solid Wastes
- Pesticides
- Toxic Wastes
- Bacteria
- Sediments
- Heated Water
- … And others

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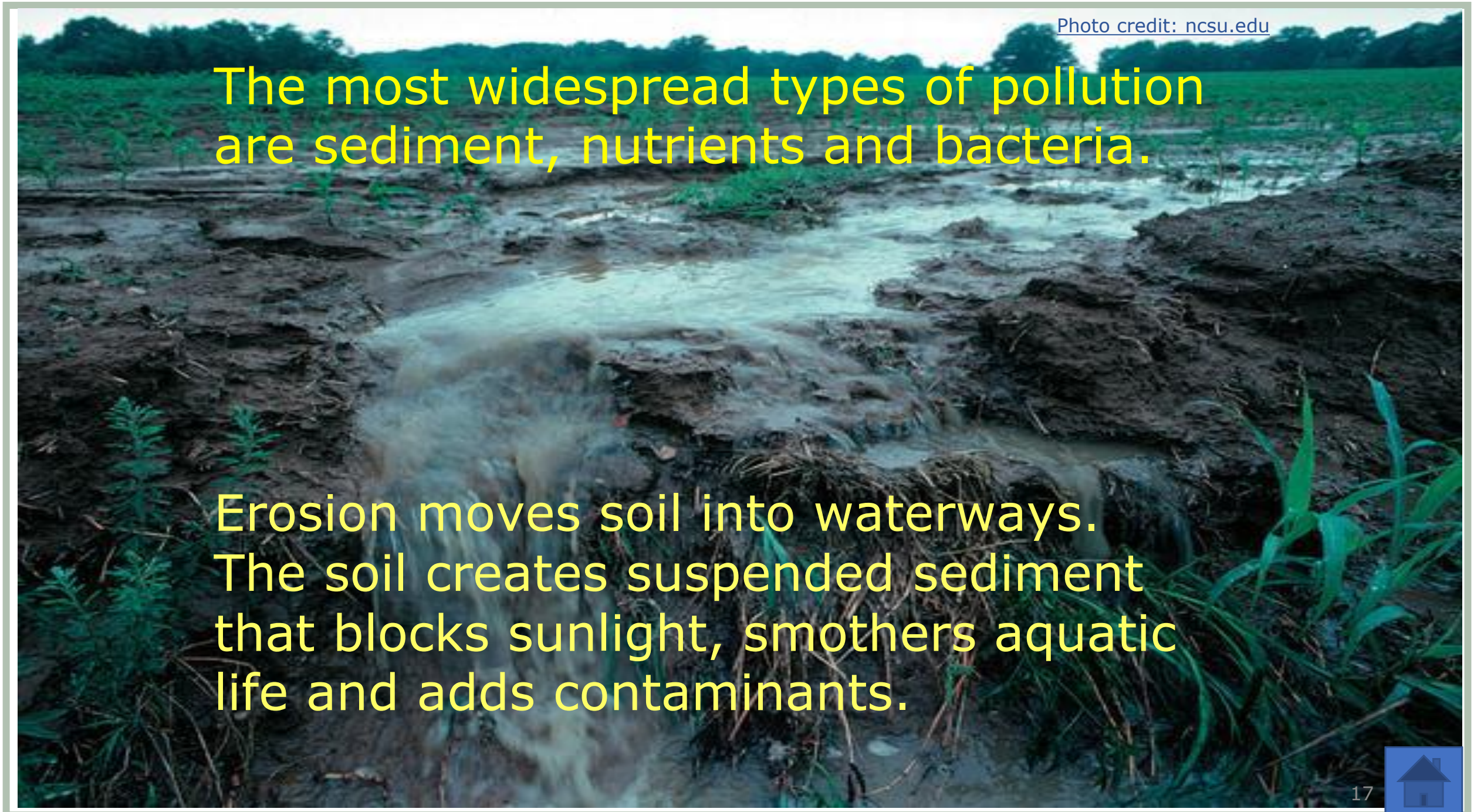


Photo credit: ncsu.edu

The most widespread types of pollution are sediment, nutrients and bacteria.

Erosion moves soil into waterways. The soil creates suspended sediment that blocks sunlight, smothers aquatic life and adds contaminants.

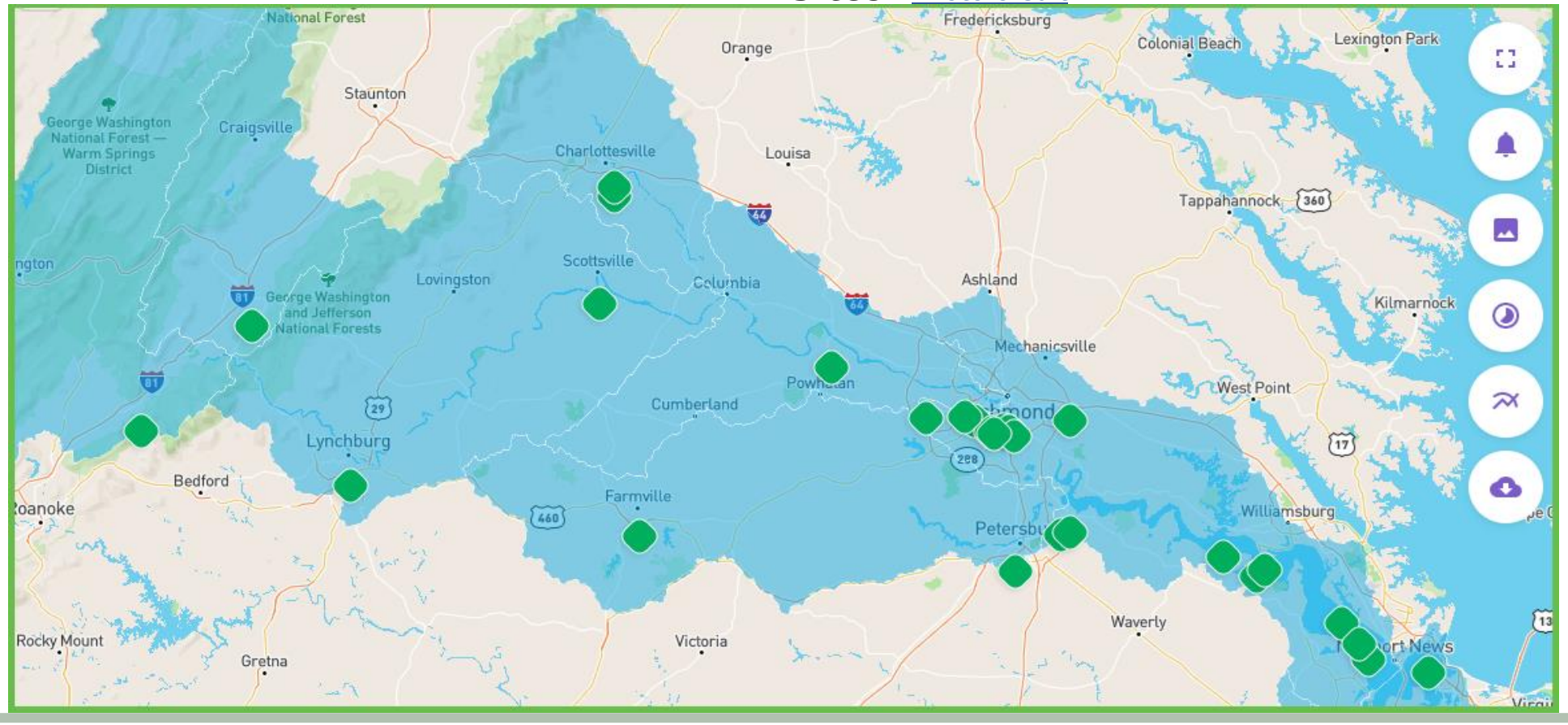
Primary plant nutrients include nitrogen, phosphorus and other elements. Excess nutrients increase algal growth. The algae die and the resulting decay consumes oxygen.

Algae in North Fork of Shenandoah River. Photo credit

Photo credit
Shenandoah Riverkeeper identified 73 herds of cattle with direct access to the North Fork, South Fork, and mainstream Shenandoah River in 2018
Partially treated sewage, farm runoff and animal wastes are major sources of nutrients and bacteria.

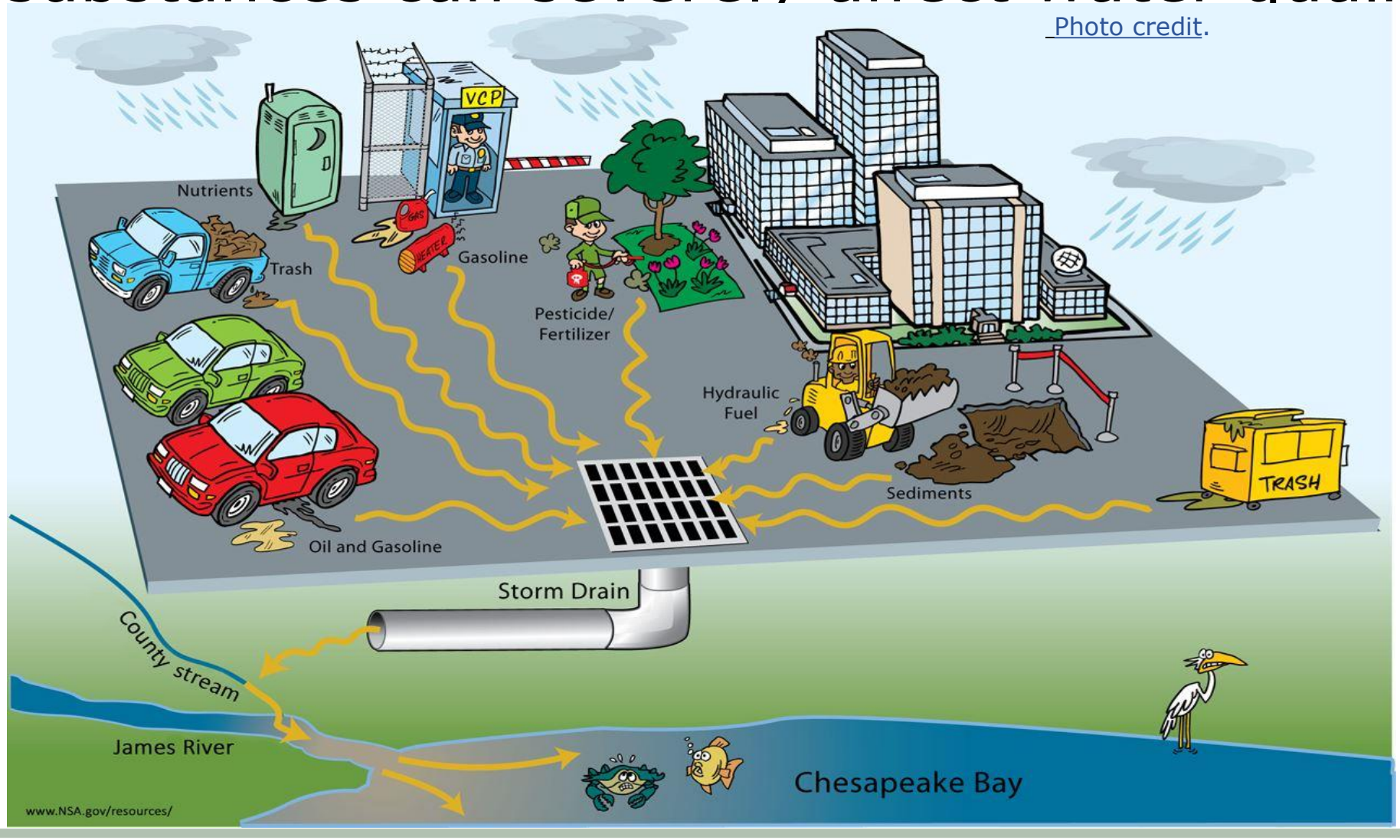
Bacterial contamination is becoming a chronic problem in many waterways. The most prevalent sources are poorly treated sewage and wildlife, pet and livestock waste.

James River Water Quality Monitoring Sites. Photo credit



In addition, petroleum products, farm and garden chemicals, heavy metals and other toxic substances can severely affect water quality.

Photo credit.



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There are many chemical measures used to determine water quality. This program will help you learn about important water quality indicators.

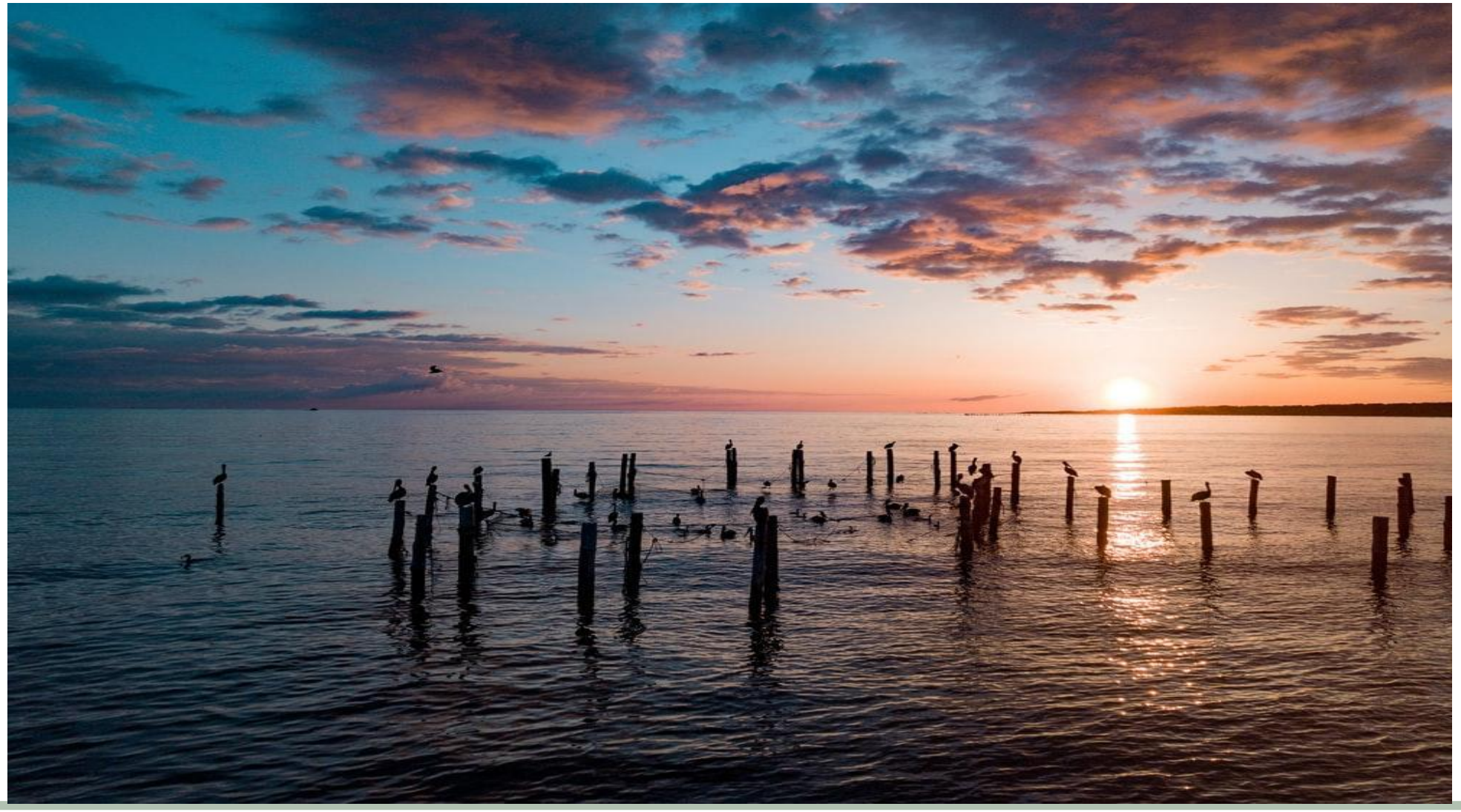


Photo credit.

Water Quality Indicators

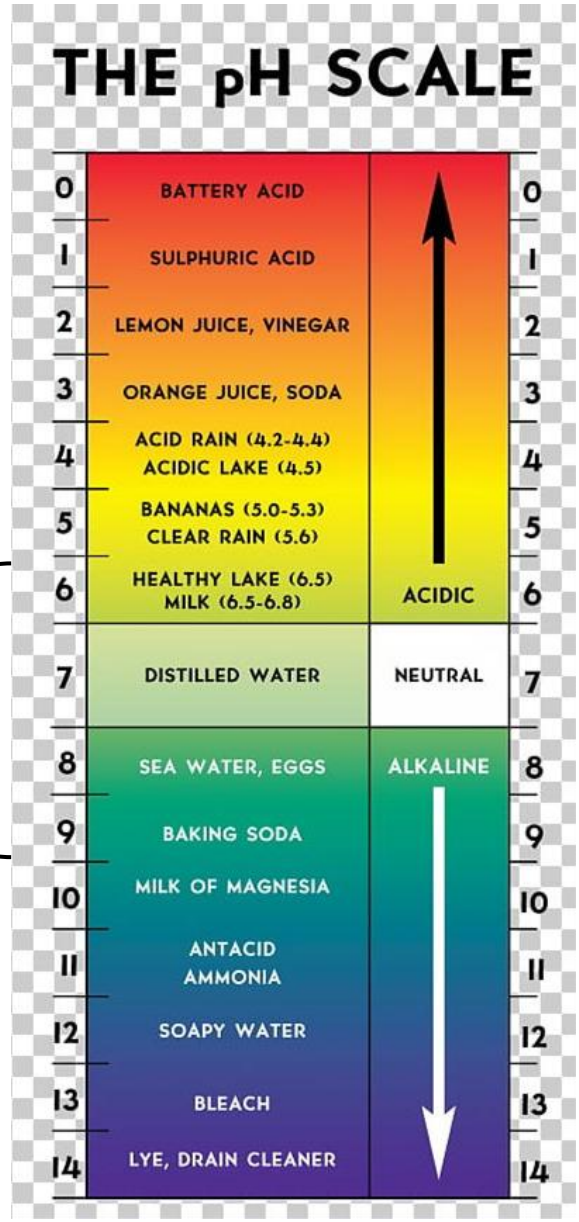
- PH
- Phosphate
- Salinity
- Sediment
- Temperature
- Toxic Chemicals
- Pesticides
- Dissolved and suspended solids
- Turbidity
- Ammonia
- Bacteria
- Hardness
- Nitrogen

pH

pH is the measure of acidity vs. alkalinity.

The pH scale is zero to 14. Seven is neutral, below seven is acidic, and above seven is basic or alkaline.

Most aquatic organisms exist within a pH range of 5.5 to 9.5.



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PHOSPHATE

- Phosphate is an important plant nutrient used for root growth
- Phosphate binds to soil particles and is not usually water soluble
- Excess phosphate can cause algae blooms and reduce water quality
- Chicken and swine production are a major source of phosphate pollution

Discharge Pipes

Hog farm in North Carolina.
Photo credit

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SALINITY

Salinity refers to the salt concentration in water, mostly sodium chloride

Salinity is measured in parts per thousand (ppt) or grams per liter

Ocean water has a salinity of about 35 ppt

Dredging at Virginia Beach after a hurricane, 2019, was halted due to sea turtle migration. Photo credit

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SEDIMENT

Sediment is the "conglomerate of materials, organic and inorganic, that can be carried away by water, wind or ice. Erosion causes loose soil to enter waterways." Sediment can be carried downstream by water flow

(Photo Credit: NASA Visible Earth, via USGS)

Suspended sediment blocks sunlight and reduces dissolved oxygen.

Heavier sediment particles quickly settle out of the water.

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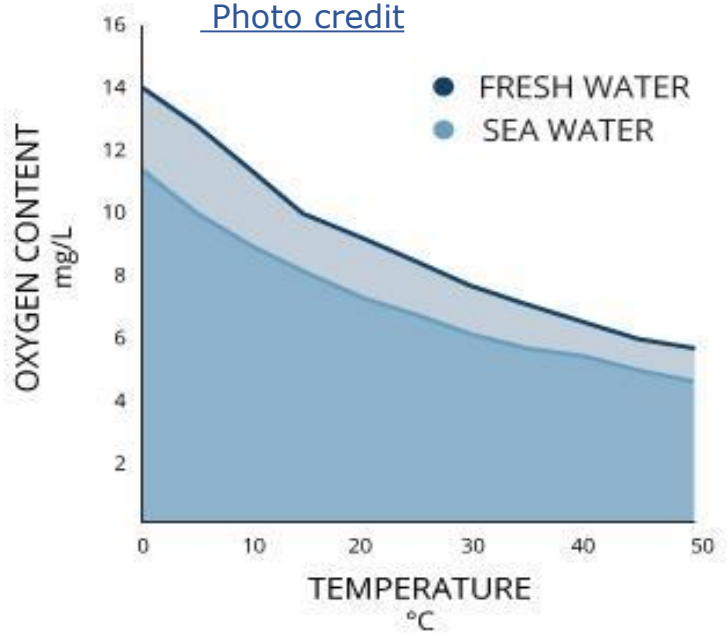
TEMPERATURE

Temperature affects the oxygen-carrying capacity of water. Dissolved oxygen concentrations are affected by diffusion and aeration, photosynthesis, respiration and decomposition

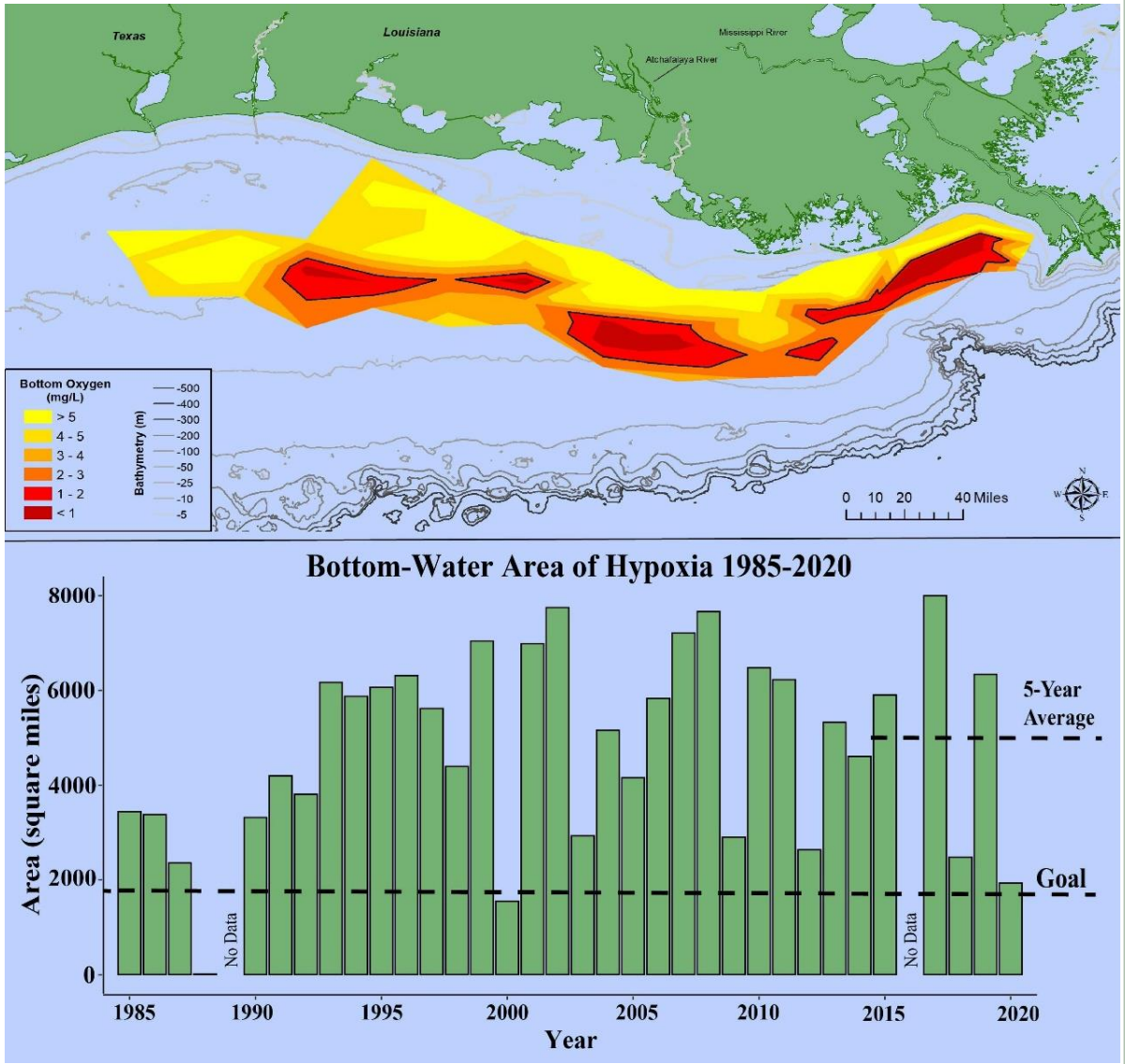
Rapid temperature change and temperature extremes can stress aquatic organisms. Dissolved oxygen depletion is the most common cause of fish kills

Photo credit



As the water warms, the amount of dissolved oxygen decreases.

Hypoxic, so called ‘Dead Zones’ are areas where the oxygen concentration is so low that animals can suffocate and die. The largest hypoxic zone in the U.S. and the second largest worldwide forms in the northern Gulf of Mexico adjacent to the Mississippi River from runoff from farms and cities that drain the Mississippi River.



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TOXIC CHEMICALS

Toxic chemicals usually come from industry and energy production.

The effects are often not known until years after they have entered the environment.

Toxic chemicals include heavy metals (lead, mercury), organic compounds (DDT, PCB), inorganic substances (arsenic) and others.

Many common household chemicals are toxic to aquatic life (cleaning fluids, paints, thinners, polishes, etc.).

PESTICIDES

Pesticides are rated by a number of factors:

- How well they adhere to soil
- How water soluble they are
- How long they last in the environment
- How they affect organisms

Some types of pesticides include:

Herbicides	Insecticides	Fungicides
Algicides	Miticides	Rodenticides

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DISSOLVED SOLIDS

Natural sources of dissolved solids in groundwater include bedrock and salt deposits; additional sources include on-site sewage systems, runoff and wastewater from urban, industrial, or agricultural areas, runoff from roads and wastewater from extraction activities such as coal mining and natural gas drilling.

Suspended sediment and dissolved substances reduce the amount of oxygen water can carry.

As suspended sediments settle, they can smother bottom (benthic) organisms.

A large part of the Chesapeake Bay has low dissolved oxygen.

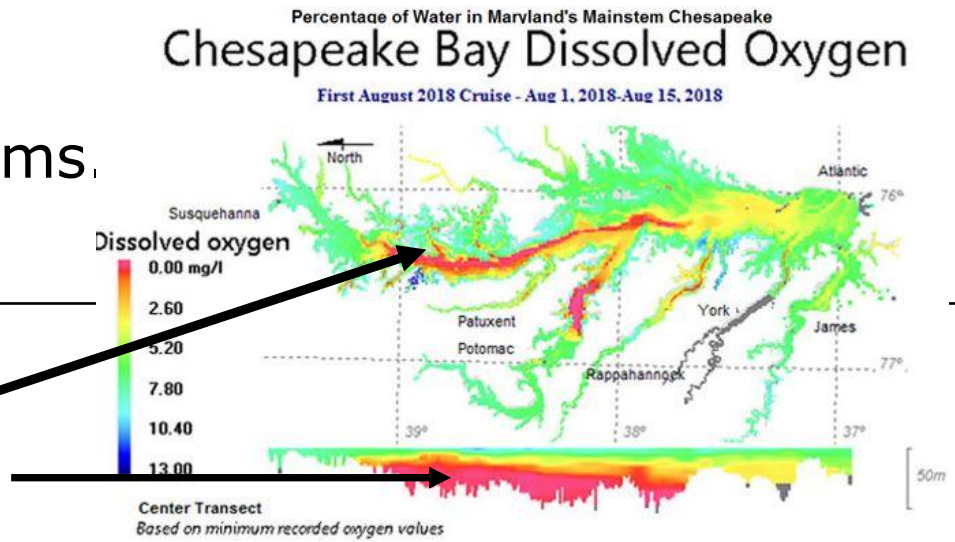

Photo credit

Total Dissolved Solids in Household Water

Data from the first August cruise: August 1-15, 2018. Courtesy MD DNR

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TURBIDITY

- Turbidity refers to water clarity
- Sediments suspended in the water increase turbidity
- Clay and silt particles produce most of the turbidity
- Turbidity is related to hardness
- High turbidity prevents light from reaching aquatic life

Big Otter River at U.S. Route 460 in Bedford County, Virginia, June 15, 2013. Photo credit

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AMMONIA

- Ammonia is produced by the decay of protein matter and animal waste.
- Ammonia is toxic to most aquatic life, especially at high pH.
- Bacteria readily convert ammonia to nitrate (a plant nutrient).
- Ammonia is a form of nitrogen.

BACTERIA

- Most bacteria are important in nutrient and other biological cycles.

- Excess nutrients cause algal blooms. As algae die and decay, the high bacterial load rapidly consumes dissolved oxygen.

Fish kill due to low dissolved oxygen.
Photo credit

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BACTERIA

Certain types of bacteria indicate animal and human waste pollution.

Escherichia coli are coliform bacteria found in the intestines of warm-blooded organisms. Most strains are harmless but one *E. coli* strain can cause severe diarrhea and kidney damage.

HARDNESS

Hardness refers to the concentration of calcium and magnesium in water.

Hard water has high concentrations of these elements. Soft water has low concentrations.

Water hardness often originates from limestone.

Excess hardness causes quality problems.

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NITROGEN

Nitrogen makes up 80% of the atmosphere

Nitrogen is a primary plant nutrient

Nitrogen is water soluble and moves easily from surface to groundwater

Photo credit

Excess nitrogen causes algal blooms that reduce water quality

Photo credit: usgs.gov

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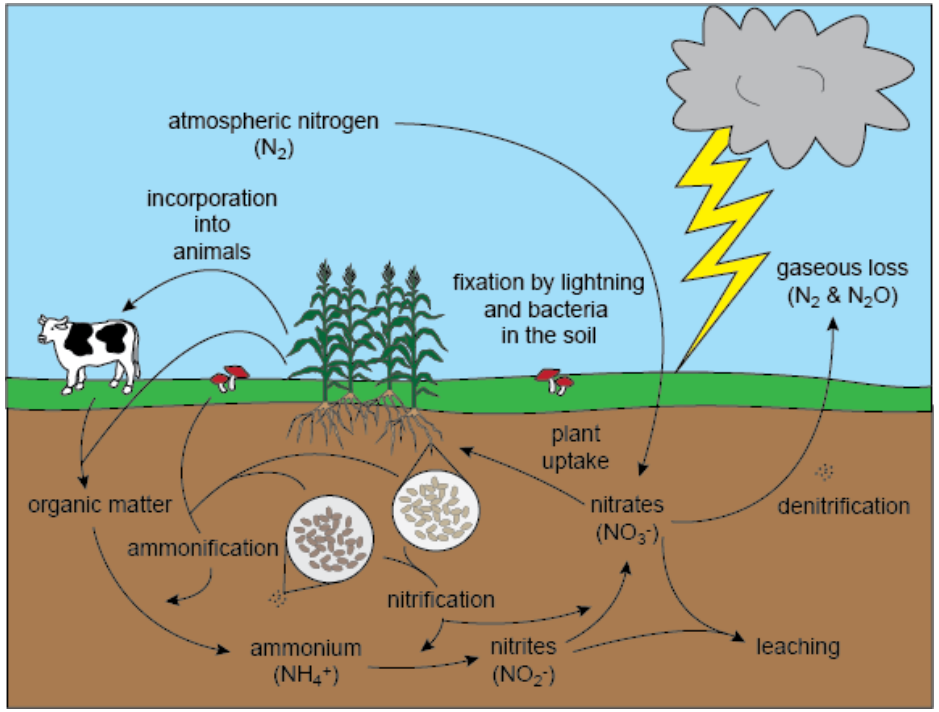
Nitrogen Cycle

Under normal conditions, the nitrogen cycle keeps the amount of available nitrogen in balance with the demands.

However, excessive use of fertilizers and nutrient-rich sewage release have created a surplus of nitrate in waterways.

The result has been excess algae and bacteria with reduced dissolved oxygen.



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Valuable Water Quality Web Sites (Click on bars to go to sites)

USGA Water Information Pages

US Environmental Protection Agency

Chesapeake Bay Program

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PARTS PER MILLION

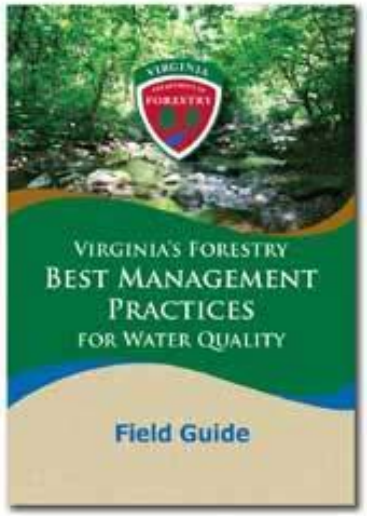
Most dissolved substances found in water are measured in parts per million (ppm) or even smaller amounts.

This means that for every one million parts (units) of water there is a certain number of parts of the substance.

Virginia's Anti-Degradation Policy

Virginia has a constitutional mandate to protect the quality of its natural resources (Virginia Constitution, Art.XI, Sec. 1). In keeping with this mandate the state has adopted an anti-degradation policy which requires the protection of existing high quality surface waters (lakes, rivers, streams, etc.) and groundwater. The policy also provides for the restoration of all other waters of the state to a condition that would permit all reasonable uses (VA. Code Sec. 62.1-44.4(2). The Virginia Water Control Board is responsible for setting groundwater quality standards.

You can help by adopting effective Best Management Practices for your home, farm, school and community.



Click on image to find this document. Photo credit

Apple Orchard Falls, Sedalia.
Photo credit

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Steps in Designing a Water-wise Landscape

- Group plants with similar watering needs together (hydrozones)
- Limit lawns to the appropriate size for your needs (replace some lawn with trees, shrubs, perennials)
- Limit areas with high irrigation needs
- Reduce runoff and erosion
- Provide water-wise maintenance and irrigation practices

Suggested Readings

A Primer on Water Quality (5 pages)
Groundwater Quality
Home Water Quality
Pesticides and Aquatic Animals: A Guide to Reducing Impacts on Aquatic Systems (24 pages)
Virginia's major waterways

Test Your Knowledge

Crossword Puzzle

Help Desk Quiz

Apply What You Have Learned

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Apply What You Have Learned

1. Identify one potential source of water pollution on your property
2. Develop a hydrozone in your yard / garden
3. Have the water going into your house tested for hardness and pH

Click here to return to 'Tests of Knowledge'

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Help Desk Quiz

Answers on next slide

1. What steps can I take to reduce the amount of water I use in my gardens and flower beds?

1. How much should I water my vegetable garden?

1. Can I use "gray" water (or household waste water) for my garden plants?

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Click here to return to 'Tests of Knowledge'

Help Desk Quiz

1. What steps can I take to reduce the amount of water I use in my gardens and flower beds?
   Answer: Group plants together by their water needs; limit the amount of lawn you have (plant trees with large mulch areas around them or perennial flower beds that require less water); reduce runoff; use drip irrigation to water plants; if plants will tolerate shade, plant them in the shade to reduce water requirements; use mulch and ground cover; add organic matter to planting areas
2. How much should I water my vegetable garden?
   Answer: One inch per week either from rain or irrigation.
3. Can I use "gray" water (or household waste water) for my garden plants?
   Answer: Yes, but with care. No more than about ½ gallon per square foot per week. The greatest danger is from the salts in soaps

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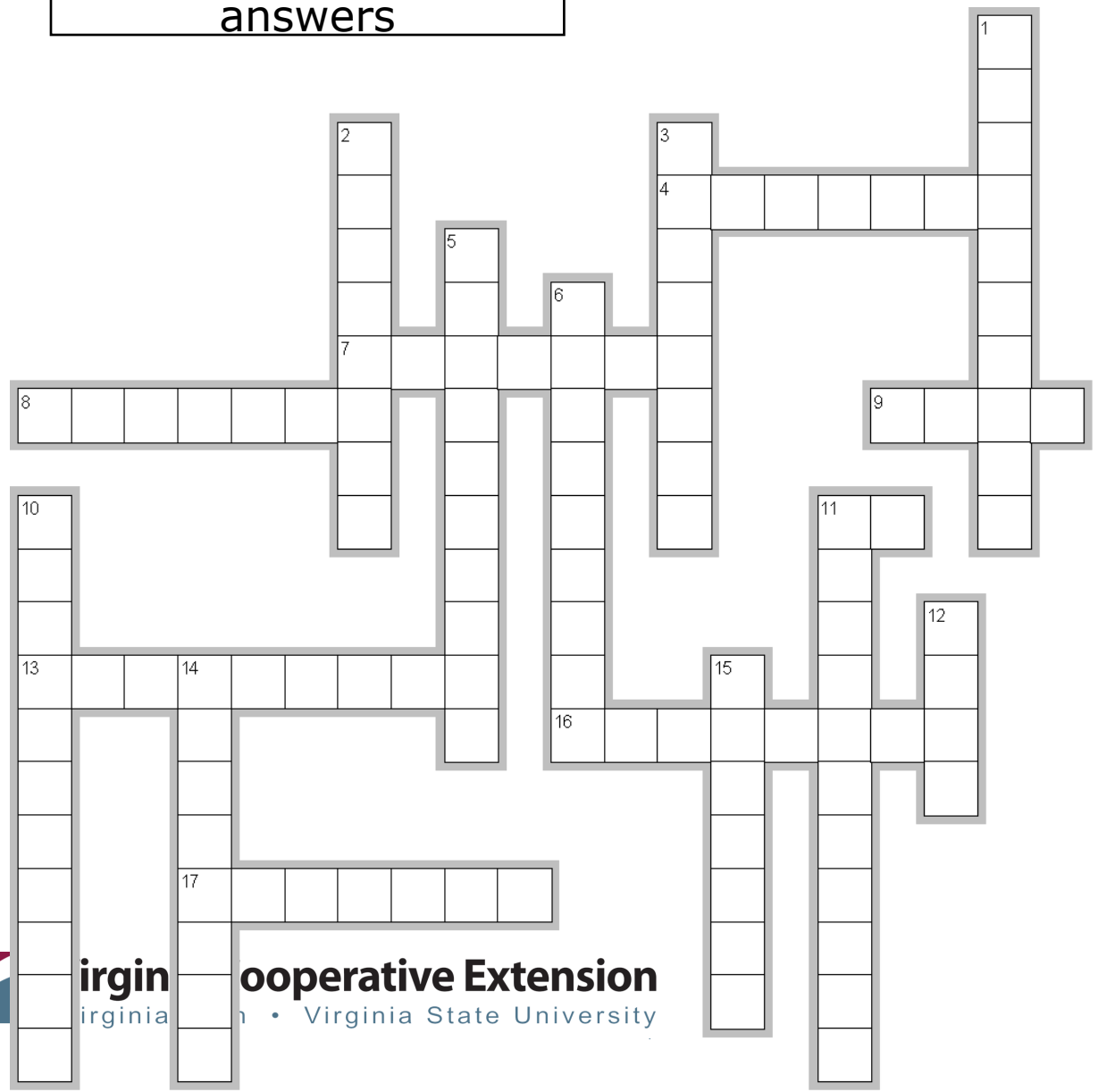
Crossword Puzzle
Next Slide has answers



Answers

ACROSS

4. **Product of protein decay**
7. **Soil on the move**
8. **Groundwater layer**
9. **PH less than 7**
11. **Power of the Hydrogen**
13. **Important in root growth**
16. **Particles of organic matter**
17. **Primary plant nutrient**

DOWN

1. **Buffers pH**
2. **What coliform is**
3. **Measures calcium and magnesium**
5. **Urban runoff**
6. **What oxygen is in water**
10. **Measured in ºF and ºC**
11. **Pollution from a pipe**
12. **PH greater than 7**
14. **Saltwater measure**
15. **From living matter**

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Created with EclipseCrossword — www.eclipsecrossword.com

Crossword Puzzle - Answers

ACROSS

4.	Product of protein decay	AMMONIA
7.	Soil on the move	EROSION
8.	Groundwater layer	AQUIFER
9.	PH less than 7	ACID
11.	Power of the Hydrogen	pH
13.	Important in root growth	PHOSPHATE
16.	Particles of organic matter	DETRITUS
17.	Primary plant nutrient	NITRATE

DOWN

1.	Buffers pH	ALKALINITY
2.	What coliform is	BACTERIA
3.	Measures calcium and magnesium	HARDNESS
5.	Urban runoff	STORMWATER
6.	What oxygen is in water	DISSOLVED
10.	Measured in ^{o}F and ^{o}C	TEMPERATURE
11.	Pollution from a pipe	POINTSOURCE
12.	PH greater than 7	BASE
14.	Saltwater measure	SALINITY
15.	From living matter	ORGANIC

Click here to return to 'Tests of Knowledge'

COPY OF WATER QUALITY QUIZ

1. Water _____ refers to the condition of the water.
   a. cleanliness b. solubility c. flow d. quality
2. Runoff from wide areas such as parking lots, farms, yards, stream banks, etc. is called non-point source pollution.
   a. True b. False
3. Chemical-laden water coming out of a pipe leading out of a factory illustrates an example of _____ pollution.
   a. turbidity b. inflorescence c. point source d. erosion
4. Pollutants can enter the groundwater through
   a. runoff b. absorption c. infiltration and leaching d. all of the above
5. In Virginia, water quality standards require an antidegradation policy: a. True b. False
6. Most dissolved substances found in water are measured in parts per million (ppm) or smaller amounts.
   a. True b. False
7. Temperature affects the oxygen-carrying capacity of water. a. True b. False
8. A water-wise landscape design utilizes water effectively by the following methods EXCEPT
   a. reducing runoff erosion b. increasing lawn areas c. grouping plants with similar water needs
   d. limiting areas of high irrigation
9. _____ refers to water clarity.
   a. Dissolved solids b. Benthic organisms c. Turbidity d. Chemical processes
10. Water quality is a fixed thing and does not depend on the use of the water. a. True b. False
11. All strains of E coli bacteria are harmful to the environment. a. True b. False

The End

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