

# Know Your Forest, Know Your Water



## Educational Workbook Topics:

- Healthy Forests = Clean Water
- How Water Flows
- Reading the Landscape
- Watersheds
- What Lives in the Stream?
- Qualities of Water
- How Much Water is That?
- Forests and the Water Cycle
- Soil & Water
- Stream Buffers
- Additional Educational Opportunities

[www.ncforestservice.gov](http://www.ncforestservice.gov)

Cover Photo: Pond at Jordan Lake Educational State Forest

# Healthy Forests = Clean Water

**North Carolina has abundant and diverse forests:** pines, oaks, cypress, gums, hickories, maples and many more. There are approximately 34.4 million acres of land in North Carolina, with almost 19 million of those acres being forests. That's enough forest to cover almost 14.5 million football fields!

**Forests provide many things:** wood, paper, cardboard boxes, charcoal, food, and fuel, among other products. Forests also provide many benefits such as cleaning the air and water, homes for animals and places for recreation.



**Most of the forests are privately-owned.** These owners include farmers, families, investors, hunters and people who just enjoy the outdoors. Foresters help woodland owners by giving advice on how to manage their forest, how to sustainably harvest trees, improve wildlife habitat and regrow the next generation of forest.

**Proper management allows forests to provide the things we all need and also keeps the water clean.** When working in the woods, foresters and loggers use best management practices, abbreviated as 'BMPs,' to protect soil, water, wetlands and wildlife. The N.C. Forest Service routinely monitors logging sites to see if they comply with the water quality rules.

**The water you drink may have flowed through a forest!**

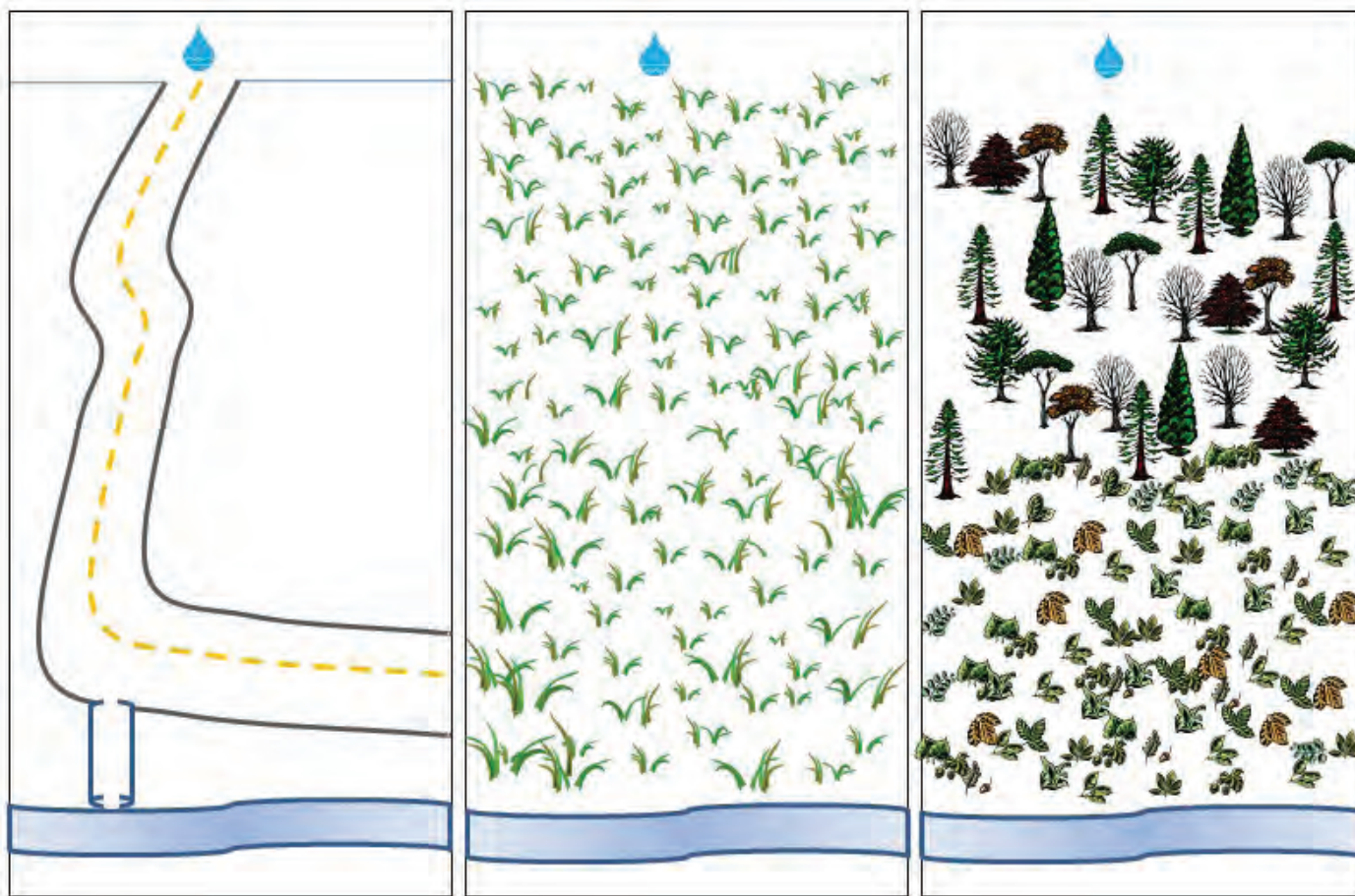
Many lakes where drinking water is taken from are surrounded by forests, and the streams that feed those lakes are in forests, too. Over one-half of the drinking water from North Carolina's rivers or lakes gets its start in a forest!



**QUESTION 1: What percentage of North Carolina's total land area is covered in forestland?**

# How Water Flows

Let's play a game! Each box has a drop of water at the top that needs to flow downhill to the stream at the bottom. Draw a line for each water drop to follow, without touching your line to any objects in the box. Keep track of how much time it takes to draw each line.



Which path was the fastest and straightest? Which was the slowest and longest?

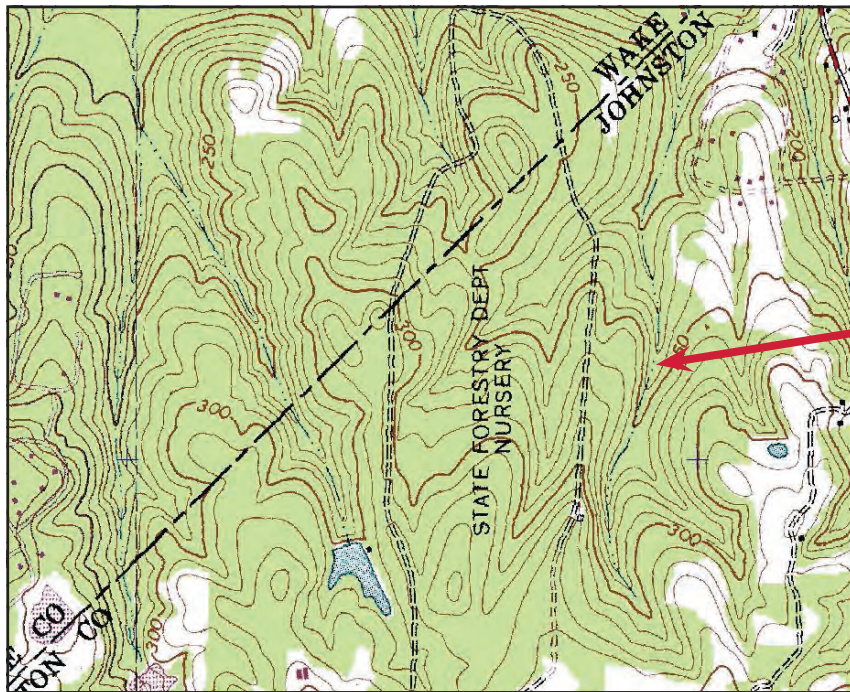
- Water that flows on pavement cannot slow down before entering a stream. It can wash oil, dirt, trash and other pollution into the stream. Never pour waste fluids into the street gutter.
- Water that flows across a crop field, pasture or grassy area goes a little slower. The soil and roots of plants absorb water like a sponge, and the leftover water either flows slowly across the ground or it gets filtered into the stream.
- Water that flows through a forest takes a long time! The seedlings, roots, leaves and pine needles slow the water, letting dirt settle out and giving time for the water to soak deep into the ground. This groundwater helps trees grow, maintains streamflow and replenishes wells.

**QUESTION 2: If you have a bare spot of land that is not being used, what could you do to slow down the water?**

# Reading the Landscape

There are many types of maps that can help you find streams and read the lay-of-the-land. But, not all streams are shown on these maps. To know for sure, you need to get out into the woods and examine. Make sure you get permission from the landowner before exploring!

The type of map shown here is called a topographic map. It shows the steepness of the land, using brown curving lines called “contour lines.” Streams are shown as solid blue lines, or dashed and dotted lines. Forest areas are shown in green, and farm fields or open areas are shown in white. Other objects shown include roads, trails and ponds.



The map at the bottom is the same as the map on top, except it is tilted to show a 3-D view of the hills and valleys.

## Some things to notice:

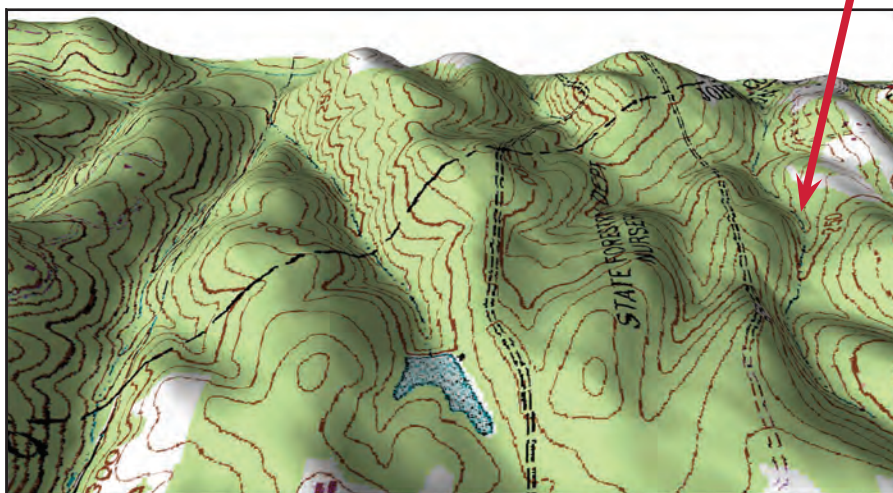
*Streams are down in the bottom of the valleys.*

*Hilltops are shown by brown contour lines drawn as a circle or oval.*

*When the brown contour lines are drawn closer together, that means the land is steep.*

Even when streams are not shown on the topographic map, foresters will explore places where many contour lines come together in a V-shape on the map. Those areas often have a stream or waterway on the ground.

Water will flow downhill and concentrate in the valley bottoms to form streams.



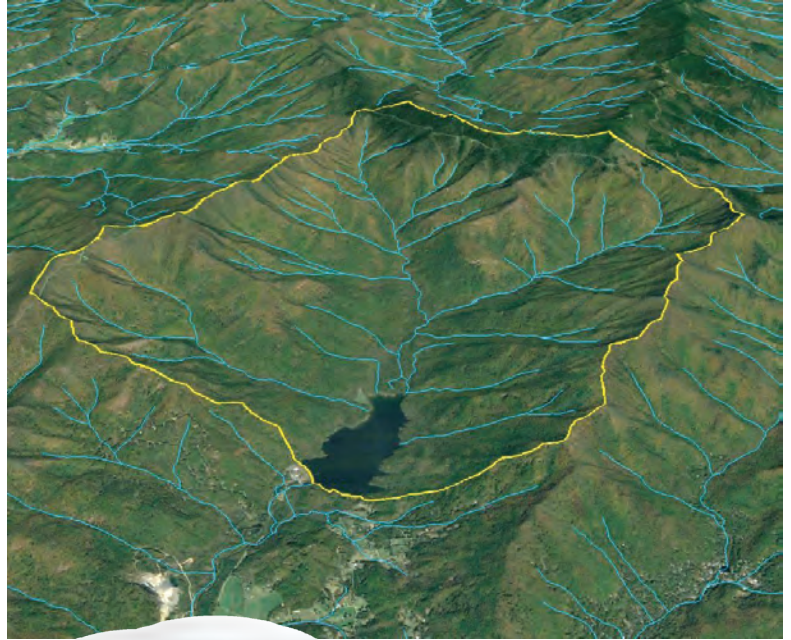
**QUESTION 3: How many streams can you find on the uppermost (top) map?**

# Watersheds

A watershed is an area of land where all of the water drains down into the same stream, river, pond or lake. Some watersheds are small, perhaps like the size of your school. And some are large, such as a river basin. North Carolina has 17 major river basins, and nearly all of them are at least half-covered by forests.

Forests keep water clean and flowing in streams year-round. This is why cities get their drinking water from watersheds that are mostly covered by forest.

This 3-D map (right) shows the 14,000-acre watershed area for Burnett Lake, which provides drinking water for Asheville, NC. The watershed boundary is highlighted on the map by the yellow line, so you can see it here.



## Use BMPs to Keep the Water Clean!

It is important to conserve and manage watershed forests to keep them healthy and vigorous, prevent wildfire, and avoid uncontrolled damage by insects, disease or invasive/nonnative species.

By using forestry best management practices (known as BMPs), foresters and loggers can harvest areas of trees once in a while, then establish new seedlings, manage the forest and still keep the water clean.

**QUESTION 4: Do you think it costs more or less money to clean the water for drinking, when it comes from forests?**

# What Lives in the Stream?

The type of insects that live in a stream can give you a good idea of how healthy and clean that stream and its upstream watershed are. There are three categories of water insects.

**Sensitive:** Cannot survive with pollution (needs clean water).

**Moderate:** Able to live with some pollution.

**Tolerant:** Able to survive in dirty, polluted waters.

Sometimes the pollution is hard to see. Sediment is the most frequent type of pollution and is easy to see. Other things like bacteria, chemicals, too much nutrients or high water temperature can also cause problems and can be hard to see, but the insects know!

Studying aquatic insects is quicker and costs less money than taking water samples and analyzing them in a laboratory, and has shown to be a reliable method to get a snapshot of stream health. The insects and animals shown on this chart are only a small sample of those most commonly found in streams.

**Where to Look:** Insects like to hide!

- Look under wet rocks, packs of leaves, twigs or chunks of wood in the stream.
- Some insects build a hard tube sleeve and stay inside that tube. So, you have to search for their tube sleeve, which can look like a small hollow twig, about an inch long or less.
- And they move fast, too, so watch for something moving around.

<b><u>Sensitive</u></b>	<b><u>Moderate</u></b>	<b><u>Tolerant</u></b>
Caddisfly	Clams	Aquatic Worm
Dobsonfly	Crane Fly	Blackfly (larvae)
Mayfly	Crayfish	Leech
Riffle Beetle	Damselfly	Midges (larvae)
Stonefly	Dragon Fly	Snails
Water Penny	Scud	
	Sowbug	



Above: A Caddisfly inside its tube, stuck onto a small twig.



Streams in the forests support insects, birds, amphibians and other wildlife.

**QUESTION 5: Most insects you find in streams are in a larval, nymph or pupa stage. What is that process called?**

# Guide to Macroinvertebrate Taxa Groups and Aquatic Pollution Tolerance

## Group 1 : SENSITIVE ORGANISMS

POLLUTION-SENSITIVE OR INTOLERANT ORGANISMS, Their dominance indicates Good Water Quality



**Mayfly (nymph)**  
*Insecta: Ephemeroptera*  
 plate-like or feathery gills on sides of lower body; three (sometimes 2) long, hair-like tails



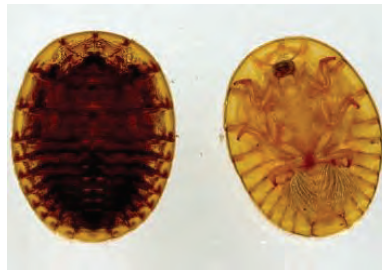
**Stonefly (nymph)**  
*Insecta: Plecoptera*  
 two hair-like tails; six jointed legs with two hooked tips each; big antennae; no gills on lower half of body



**Caddisfly:**  
*Insecta: Trichoptera*  
 six jointed, hooked legs just behind head; 2 hooks at back end; may be in a case made of stones, leaves or sticks; non-netspinning caddisflies have no bushy gills along bottom



**Freshwater Mussels (adult)**  
*Molluska: Bivalvia*  
 two hinged, calcareous shells



**Water Penny (larva)**  
*Insecta: Coleoptera*  
 shaped like a tiny, grey, oblong frisbee; 6 tiny legs on bottom; slow crawler



**Fishfly (larvae)**  
*Insecta: Megaloptera*  
 resemble Hellgrammites, but are smaller and have no gill tufts



**Dobsonfly larva (aka Hellgrammite)**  
*Insecta: Megaloptera*  
 dark body; six jointed legs; large, pinching jaws; many pointed feelers along edge of body; two small hooks at back end; feathery tufts of gills along side of body



**Gilled Snail (adult)**  
*Molluska: Gastropoda*  
 shell opens on the right and is covered by a hard shield-like operculum



**Riffle Beetle (adult)**  
*Insecta: Coleoptera*  
 oval body covered in tiny hairs, does not swim or surface

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## Group 2 : MODERATELY-SENSITIVE ORGANISMS

MODERATELY POLLUTION TOLERANT ORGANISMS, found in wide range of water quality conditions



CraneFly (larvae)  
*Insecta: Diptera*  
4 finger-like lobes at back end; milky green to light brown; caterpillar-like segmented body



Damselfly (nymph)  
*Insecta: Odonata*  
body ending in 3 oblong fan-like plates (tracheal gills); 6 thin, hooked legs; smooth tapered sides of body



Dragonfly: Order *Odonata*  
*Insecta: Odonata*  
large eyes; wide oval to round abdomen; 6 hooked legs



Scud (adult)  
*Crustacea: Amphipoda*  
body higher than wide; shrimp-like appearance; white to gray in color; swims laying on its side; more than 6 legs



Crayfish (adult)  
*Crustacea: Decapoda*  
lobster-like; 8 walking legs and 2 pinching claws



Water Beetle larvae  
*Insecta: Coleoptera*  
light-colored; 6 legs on upper 1/2 of body; strong jaws; short antennae; body smooth or with hair-like projections or knobs



Sowbug (adult)  
*Crustacea: Isopoda*  
oblong body, wider than high; gray in color; more than 6 legs; long antennae



Fingernail Clam (adult)  
*Mollusca: Bivalvia*  
2 hinged, CaCO<sub>3</sub> shells that are thin & fragile; adults 2.5 cm or smaller; hinge near middle



Whirligig Beetle (adult)  
*Insecta: Coleoptera*  
short, fan-shaped middle and hind legs; frong legs long & slender; floats on surface



Water Strider (adult)  
*Insecta: Hemiptera*  
slender, long-legged bug; surface film dweller



Water Scorpion (adult)  
*Insecta: Hemiptera*  
slender, long-legged bug; 2 long grooved filaments for breathing underwater

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## Group 3 : TOLERANT ORGANISMS

HIGHLY POLLUTION TOLERANT ORGANISMS, can be found in any quality of water, their dominance usually indicated poor water quality



Midge fly (larva)  
*Insecta: Diptera*  
dark head; worm-like segmented body; 2 tiny legs on each side



Black fly (larva)  
*Insecta: Diptera*  
one end of body wider; black head; suction pad on end



Horse fly (larva)  
*Insecta: Diptera*  
robust and worm-like; 1" in length or longer; tapered at both ends



Drone fly (larva) (aka rat-tailed maggot)  
*Insecta: Diptera*  
distinctive tube at end through which it breathes; tube up to 1" long



Pouch Snail (adult)  
*Molluska: Gastropoda*  
no operculum; breaths air; shell typically opens to left, but some species open to right



Leech (adult)  
*Annelida: Hirudinea*  
brown, grey or patterned body; body ends with suction pad; flattened, segmented worm; carnivores or parasites; moves like inch worm by contracting/extending body



Oligochaete worms  
*Annelida: Oligochaeta*  
segmented body with thin bristles (setae); round cross-section, like thin earth worms; red-pink to dark color; moves by contracting/extending or by wriggling; burrowing scavengers; tubifex common genus; head in mud, tail waving



Roundworms  
*Nematoda: Nematodes*  
slender, pale color; pointed at both ends, moves by wriggling (doesn't contract); no segments or bristles; scavengers or parasites; most less than 1 cm



Flatworms  
*Platyhelminthes: Turbellaria*  
flat body, blunt head; no segments or bristles; gray-brown to pale color; glides smoothly (does not wriggle); carnivores or scavengers

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# Qualities of Water, Part 1

## TEMPERATURE

Fish, insects, frogs and other animals that live in streams need the water temperature to stay comfortable and not get too hot. Many animals can handle cold temperatures by burrowing into the ground, hibernating or basking in sunlight. But when the water temperature gets too hot, it causes problems. On a hot sunny summer day, you enjoy being in the tree shade, right? Well, so do the fish!

North Carolina has rules against raising the maximum temperature in streams.

- For trout streams, the maximum allowable temperature is 68°F.
- For other streams in the Mountains or Upper Piedmont, the maximum allowable temperature is 84.2°F.
- For streams in the Lower Piedmont or Coastal Plain, the maximum allowable temperature is 89.6°F.

**Exercise:** Using a thermometer, take temperature readings in the stream. If possible, take multiple readings then average them. Hold the thermometer in the stream for two minutes. Wait 10 minutes between taking the next reading. Take different readings in sunny spots and then again in shady spots.

Sun Spot 1: \_\_\_\_\_ Sun Spot 2: \_\_\_\_\_ Sun Spot 3: \_\_\_\_\_ Average: \_\_\_\_\_

Shade Spot 1: \_\_\_\_\_ Shade Spot 2: \_\_\_\_\_ Shade Spot 3: \_\_\_\_\_ Average: \_\_\_\_\_

Now, average your two final answers, to get the overall stream temperature: \_\_\_\_\_

*Does the temperature of your stream fall under the maximum allowable degrees?*

**Keeping forests along streams will keep shade over the water and help control water temperatures.**

## DISSOLVED OXYGEN (D.O.)

Fish and other animals that live in streams need oxygen, just like you.

But unlike people, those animals extract dissolved oxygen that is in the water.

High D.O. is found in cool temperature waters, rapids or riffles (where water churns).

Low D.O. can occur because of warmer water temperatures that come from warmer air, shallow water, too much plant life or bacteria in the water, and stagnant water.

So, if forests provide shade to streams,  
...and shaded streams are usually cooler,  
...and cooler streams contain more D.O.,  
then that's why streams in the forest often have more aquatic life, because all the right qualities come together. **This is an example of a beneficial ecosystem service produced by forests.**

*In the photo, the N.C. Forest Service's hydrologist measures the D.O. and temperature of a stream that was restored at DuPont State Recreational Forest, to see how well the work improved trout fish habitat.*

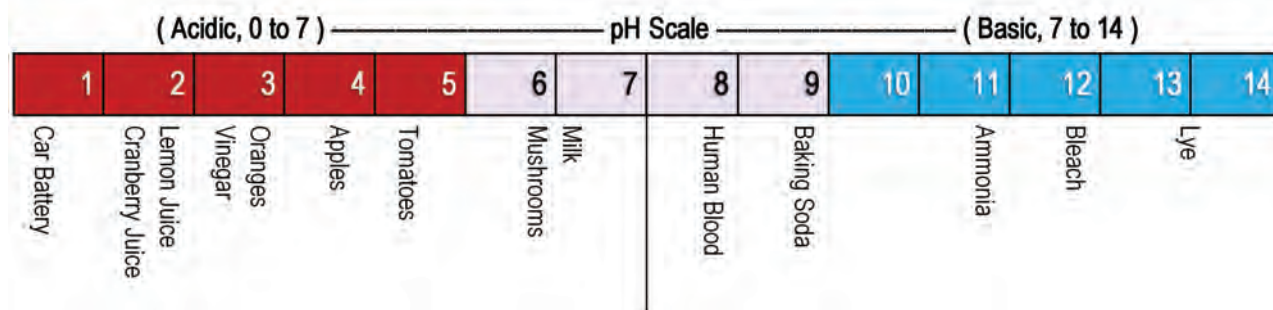


**QUESTION 6: What kinds of actions might worsen temperature or dissolved oxygen levels in a stream?**

# Qualities of Water, Part 2

## ACIDITY (pH)

Acidity is natural in water, soil and air. But too much, or too little, can cause bad chemical reactions, burns and permanent injury. The unit of measurement to determine acidity is the pH scale. The pH scale goes from 0 to 14. The pH levels for some common items are shown in the chart below for comparison.



North Carolina has rules for the pH level of water and streams:

- pH should be between 6.0 and 9.0; this is the optimum level for fish, wildlife and insects.
- pH in swamps may be lower, with the minimum allowed to be between 4.0 and 5.0.

The pH of water is strongly affected by the type of geology (bedrock and soil) and the amount of certain airborne substances, such as nitrogen, sulfur or phosphorus, deposited through rainfall.

**Forests can help to stabilize the pH levels in streams that flow through them, due to the chemical reactions within trees that occur as they absorb and release different elements.**

## TURBIDITY

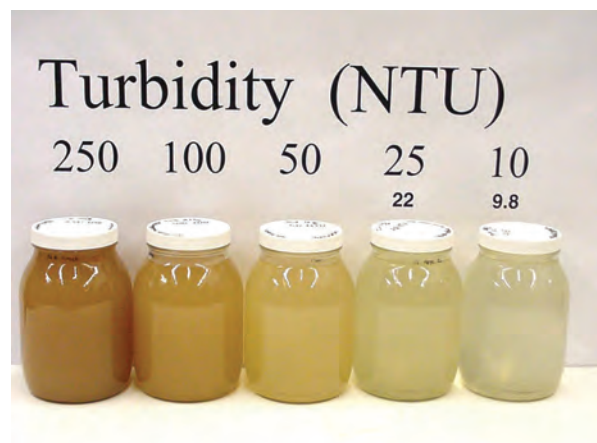
Turbidity occurs when microscopic sediment particles are suspended in water, causing the water to look cloudy, muddy or murky. It may take hours or days for these particles to settle out. Have you noticed after a heavy rain, the water in many streams turns brownish or reddish in color? That is turbidity! It is measured in nephelometric turbidity units (NTUs). North Carolina has rules that set:

- No more than 50 NTUs for streams.
- No more than 25 NTUs for lakes and reservoirs.
- No more than 10 NTUs for trout waters.

Too much turbidity can cause problems by:

- ...blocking sunlight from reaching down into the water, which can limit aquatic life productivity.
- ...smothering clams, snails and other aquatic life that live on stream bottoms and do not move fast.
- ...clogging filters for drinking water, making it more expensive and difficult to treat before use.

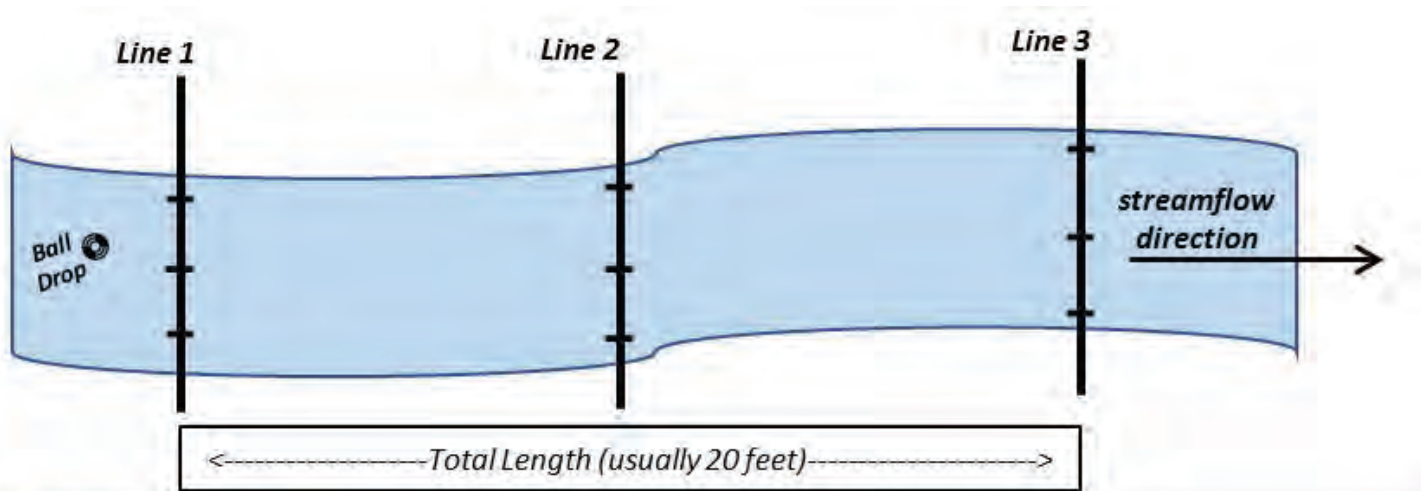
**Forests naturally filter out sediment, which also helps to reduce turbidity. But when timber is harvested or other work is done in the forest, care must be taken to limit soil disturbance by using forestry best management practices (BMPs).**



**QUESTION 7: In a healthy forest ecosystem, plants and animals rely on each other by a \_\_\_\_\_ relationship.**

# How Much Water Is That?

Use the worksheet below to estimate how much water is flowing in your stream. You will need: a ping pong ball, three pieces of string or rope, measuring tapes, stopwatch timer and calculator.

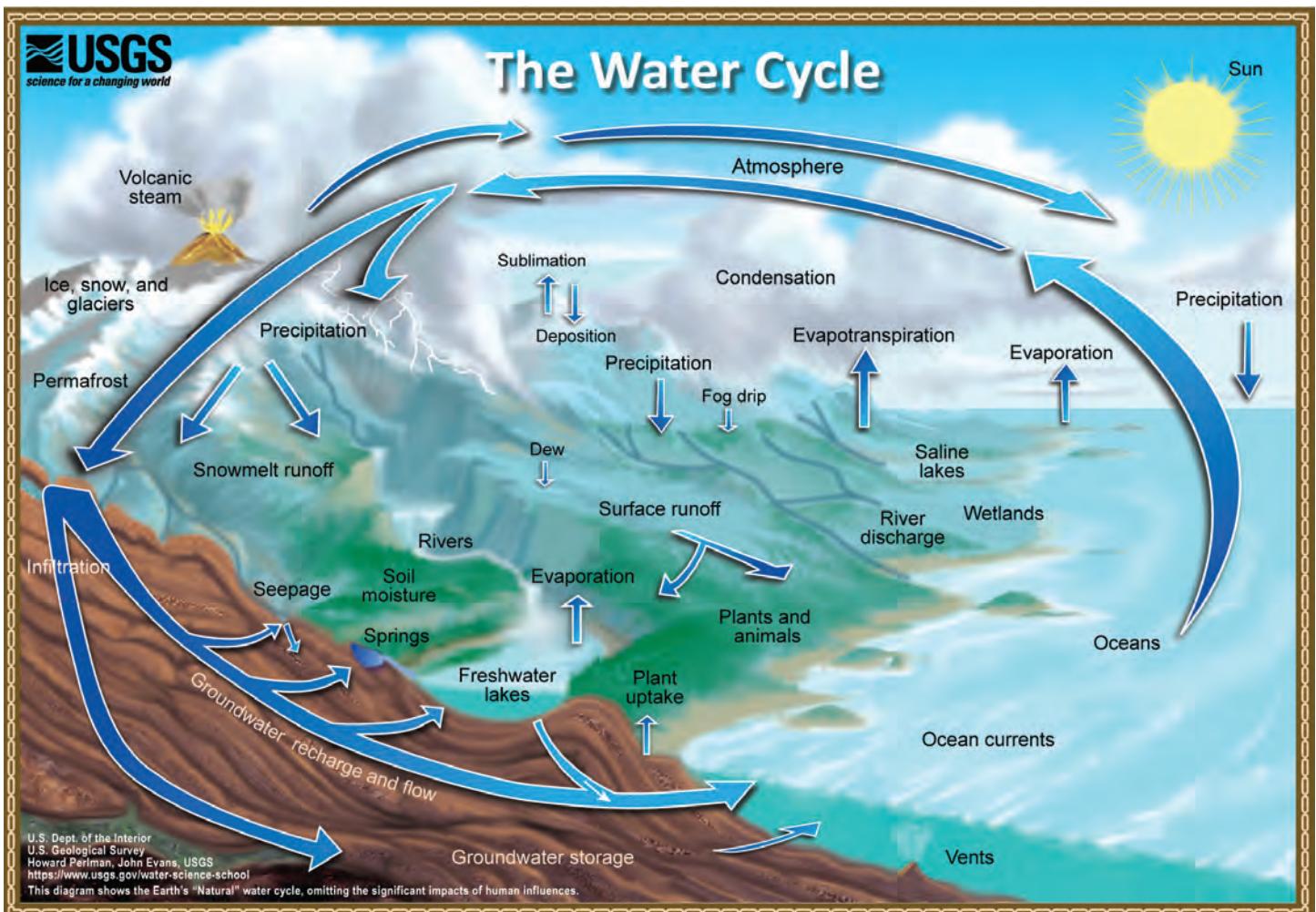


	Line 1	Line 2	Line 3	Average	Feet
Water Width (in.)					Divide Average by 12 = _____ feet wide (A)
Left Depth (in.)					Divide Average by 12 = _____ feet deep (B)
Center Depth (in.)					
Right Depth (in.)					
					From Line 1 to Line 3, Total Length: _____ feet long (C)
Multiply Width (A) x Depth (B) x Length (C) = _____ Cubic Feet of Water					
<b>Measure the Time from Line 1 to Line 3 (seconds)</b>					
First Ball Drop Race	_____ sec.			<b>Streamflow Calculation</b>	
Second Ball Drop Race	_____ sec.				
Third Ball Drop Race	_____ sec.				
<b>Average Time</b>	<input type="text"/>	sec.			
				Cubic Ft of Water:	_____ cf
				(div. by) Avg. Time:	÷ _____ sec
				<b>Est. Cubic Feet per Second (CFS)</b>	<input type="text"/>

For comparison, Niagara Falls flows on average, annually, at nearly 85,000 CFS! When there are lots of forests in a watershed, streamflows are usually more consistent and reliable, even during a drought. Forests can help reduce flooding by slowing runoff before it reaches the stream.

**QUESTION 8: When a stream has steady water flow all year, would you expect to see more or less aquatic life?**

# Forests and the Water Cycle



Sometimes you will hear people call trees 'nature's drinking straws.' That's because the trees will draw water up and out from the soil. They will use some and then release the leftover water into the atmosphere. The processes listed below are how trees are involved in the water cycle.

**Interception:** Trees catch some rain, softening its impact on the soil and reducing soil erosion.

**Throughfall:** Some rain trickles down the tree trunk and drips off the leaves. Some of this water runs off and some soaks into the soil becoming groundwater.

**Absorption:** Tree roots take in water from the soil, for carrying nutrients up and down the tree.

**Recharge:** Unused groundwater that drains into a stream, lake, swamp or ditch.

**Evapotranspiration:** A word that foresters use, combining the following two processes --

**Evaporation:** Water on leaves or needles that turns into a vapor by the sun's energy.

**Transpiration:** Water vapor released into the air through small pores, called stomata, in a leaf or needle. This water vapor is leftover after the tree uses it for photosynthesis and respiration.

## Some tree species use water more rapidly than others.

Tree species that cycle more water include pine, maple, yellow-poplar, willow and gum.

Tree species that cycle less water include oak and hickory.

**QUESTION 9: After a forest area is harvested, will the streamflow in that area often increase or decrease?**

# Soil and Water

When you think about streams and water, you also need to think about the soil.

When water washes away the soil, that's called erosion -- that's bad. We want to prevent and control unnatural erosion. Too much erosion will pollute the streams with dirt. How can you stop erosion? Wherever water flows across the surface of the ground, you want to **slow it down, spread it out and cover it quick.**

Soil contains lots of microscopic gaps that hold water droplets for tree roots -- that's good! But, if soil is compressed tightly (see picture at right, this is called compaction), there is no room to hold water and tree roots will dry out. Also, when soil is compacted, rain will quickly run off and not soak into the ground. Fast runoff causes unnatural erosion.... remember what we said about that?



Over a long time, water causes soil to change its color.

When there is persistent water on the surface or contained in the soil, the soil's color is gray, bluish or black. This is because of the reducing chemical reaction that occurs due to a lack of oxygen in the soil, known as anaerobic conditions.

When soil remains dry for most of the year, the soil's color is brown, red, orange or yellowish. This is because of the oxidizing chemical reaction that occurs when there is lots of oxygen in the soil, known as aerobic conditions, similar to how metal rusts when it gets wet and then is exposed to the air.

## Time to Get Your Hands Dirty!

Step 1: Dig a shallow hole, 8 to 12 inches deep, using a soil auger or narrow shovel.

Step 2: As you remove the soil, neatly lay it out from top to bottom, to examine it.

Step 3: Take a small handful, and rub it between your fingers.

- Does it feel gritty (sand) or squishy/sticky (clay) or slick/greasy (silt-loam or organic-muck) or a mixture of these?
- What color is the soil? (Sand is usually white or yellow; clay is red or orange; and, silt-loam is brown, black or gray.)
- Does the soil feel moist or dry? (Sand is usually dry or damp; clay is moist or wet; and, silt-loam is wet.)
- Does the feel, the color or the wetness of the soil change as the soil gets deeper? Why is that?
- How far down do you see fine roots? (Most small roots are in the top 12 to 24 inches of soil.) If soil is compacted, do you think there would be more roots or less roots?

Soil is formed in layers, like a sandwich. Different soil layers are called horizons. Usually the topsoil horizon is darker because it contains decomposed leaves, pine needles and wood.

North Carolina has many soil types. Soils in the forest hold water, retain carbon and provide habitat for beneficial worms, insects and other microorganisms that are important for growing healthy trees. Protecting the soil is important to sustain good forests.



**A + B:** Two different sandy loams. See how the color changes as you go from top to bottom. Soil "B" has more clay in the bottom (the small orange-colored clumps).

**C:** This is red clay with shades of yellow and orange.

**D:** This soil is from a stream channel, next to the water's edge. See the different soil color, when compared with the others?



**QUESTION 10: Which type of soil will water drain through fastest? Why?**



**Stream buffers are the last line of defense to keep out pollution.**

Trees, shrubs and other plants along both sides of the stream can act like a filter and catch soil. Sedimentation is the #1 pollution problem for streams and lakes.

Trees also cast shade over the stream that keeps the water cool for fish and wildlife. Cooler water usually has more dissolved oxygen, which supports better conditions for aquatic life.

Deep roots of trees, shrubs and native grass help to prevent soil erosion and also anchor the streambank to keep it from washing away when the water runs high after a rainstorm.

**What can you do to help a stream buffer?**

Leave a stream buffer strip at least 20 feet wide on each side.

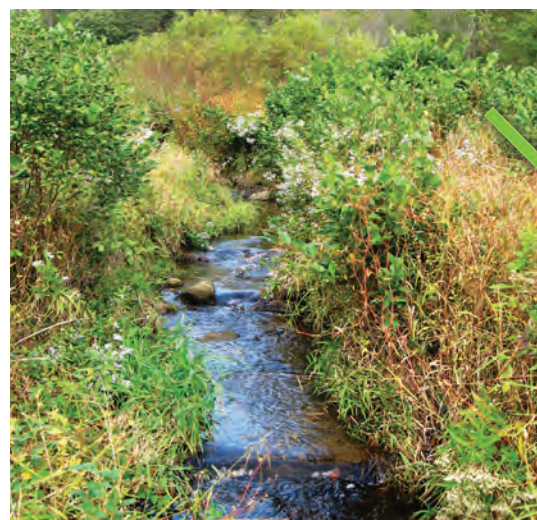
Allow native trees, shrubs, vines and plants to grow alongside the stream.

Do not mow the grass all of the way down to the stream's edge.

Plant native trees, shrubs or wildflowers in bare spots along the stream.

Do not pour any waste fluids or dump any trash into the stream buffer or the stream.

Keep bicycles, ATVs, motorbikes and other vehicles out of the stream and its buffer.



**QUESTION 11: Why is it important to keep ATVs, mowers, tractors and other vehicles out of the stream buffer?**

# NORTH CAROLINA Educational State Forests

**A DuPont State Recreational Forest**  
89 Buck Forest Road  
Cedar Mountain, NC 28718  
(828) 877-6527

**B Holmes Educational State Forest**  
1299 Crab Creek Road  
Hendersonville, NC 28739  
(828) 692-0100

**C Headwaters State Forest**  
Mailing address:  
14 Gaston Mountain Road  
Asheville, NC 28806  
(828) 665-8688

**D Tuttle Educational State Forest**  
3420 Playmore Beach Road  
Lenoir, NC 28645  
(828) 757-5608

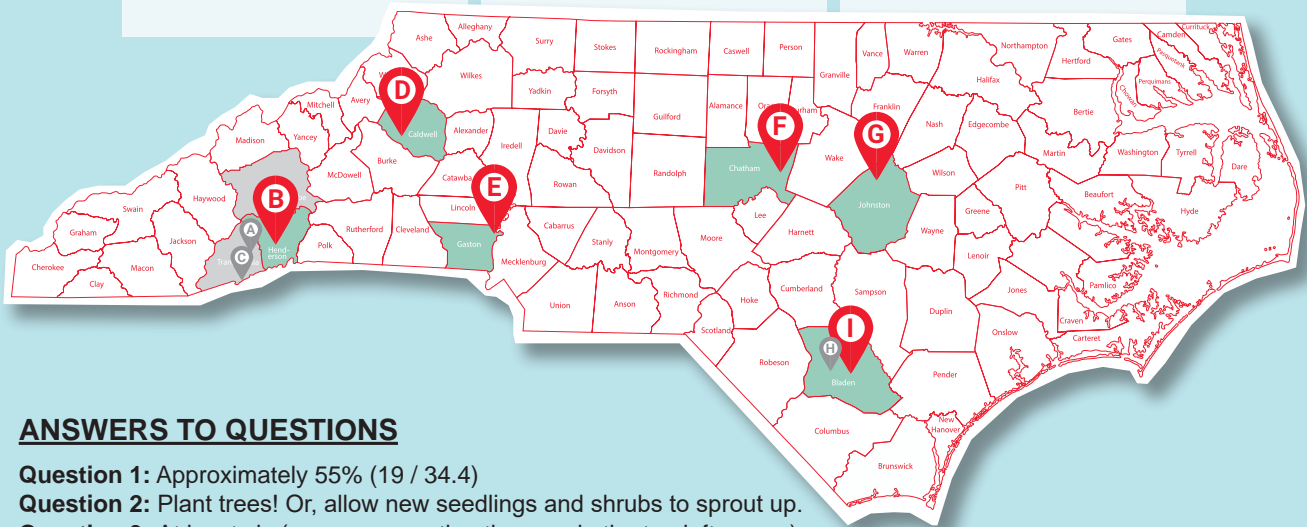
**E Mountain Island Educational State Forest**  
534 Killian Road  
Stanley, NC 28164  
(704) 822-9518

**F Jordan Lake Educational State Forest**  
2832 Big Woods Road  
Chapel Hill, NC 27517  
(919) 542-1154

**G Clemmons Educational State Forest**  
2411 Old U.S. 70 West  
Clayton, NC 27520  
(919) 553-5651

**H Bladen Lakes State Forest**  
4470 NC Highway 242 North  
Elizabethtown, NC 28337  
(910) 588-4964

**I Turnbull Creek Educational State Forest**  
4803 Sweet Home Church Road  
Elizabethtown, NC 28337  
(910) 588-4161



## ANSWERS TO QUESTIONS

**Question 1:** Approximately 55% (19 / 34.4)

**Question 2:** Plant trees! Or, allow new seedlings and shrubs to sprout up.

**Question 3:** At least six (or seven counting the spur in the top left corner).

**Question 4:** Less money because the water is already pretty clean. It does not need as much filtering to drink it.

**Question 5:** The process of changes in life stages is called "metamorphosis."

**Question 6:** Removing trees from along streams; dumping lots of tree limbs, leaves and pine needles into the water.

**Question 7:** "Interconnected" relationship. Plants and animals support each other in many phases of their life cycles.

**Question 8:** More life, because the constant flow provides a reliable source of dissolved oxygen. This type of stream is called perennial.

**Question 9:** Usually streamflow increases because the harvest temporarily interrupts a step in the water cycle.

But, as new trees regrow, they will once again intercept rainfall, process water through evapotranspiration and use groundwater. Research has shown that this effect only lasts 5-10 years after harvest.

**Question 10:** Sand, because it has larger gaps between soil particles.

**Question 11:** Prevent rutting, scraping and compaction of the soil next to the stream. This reduces the risk of soil erosion.



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