Dustin
Catalpa
Wilson
Ranch
0
1
2mi
Source: USGS, EPA | Esri, HERE, Garmin, NGA, USGS, NPS | Esri, HERE, NPS

Water Webs

Earthstar Geographics, CNES/Airbus DS
POWERED BY esri

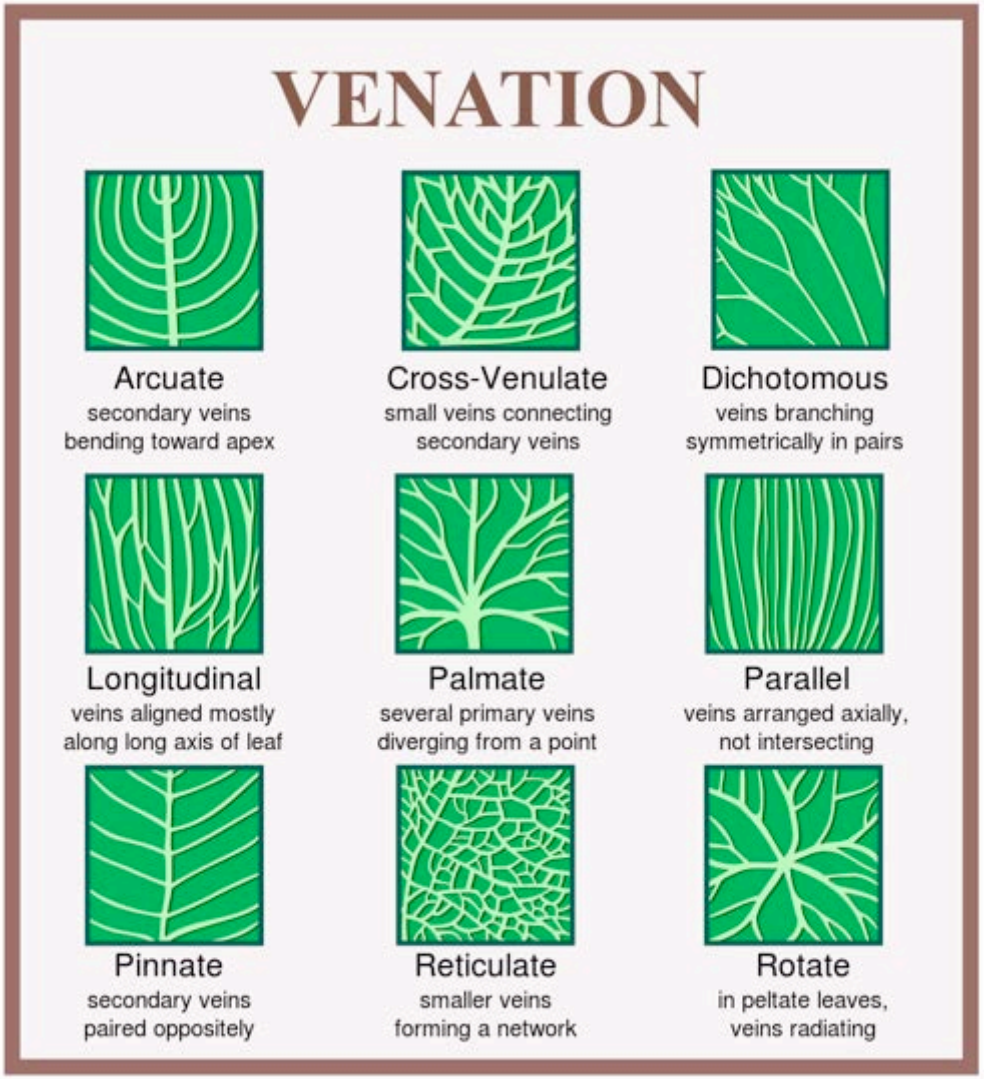
Water Webs - Objectives

- Identify drainage patterns and use new terminology
- Associate drainage patterns with observed features in aerial photos

New Terminology

- Drainage Network – the web of channels that drains water from the landscape
- Drainage Pattern – the manner in which the channels drain the landscape as a function of land topography, climate, and geology.

Part 1 – Concept Introduction

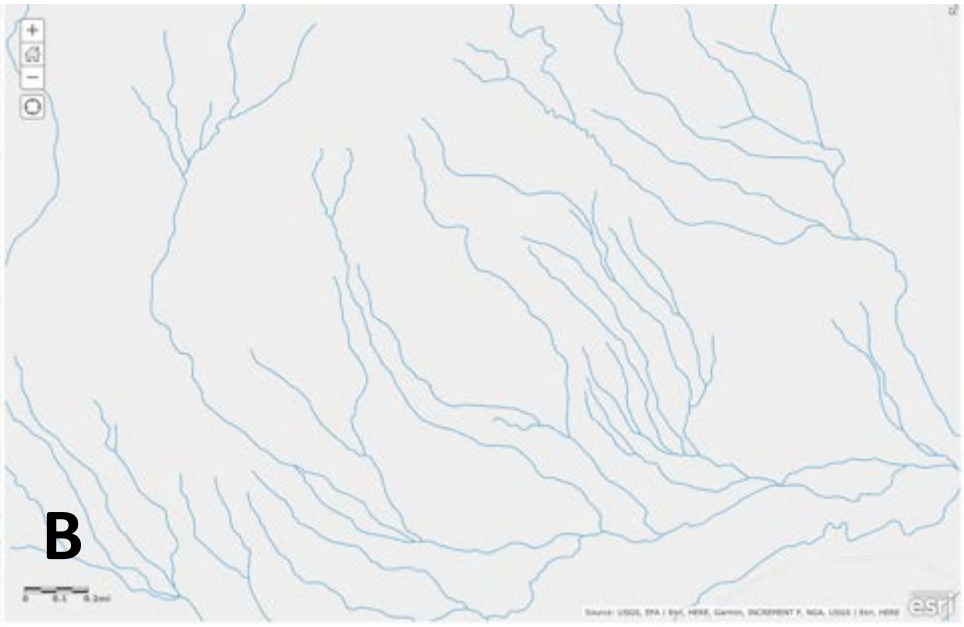


Part 1 – Concept Introduction

Part 2 – Communication

- Grab a partner!

A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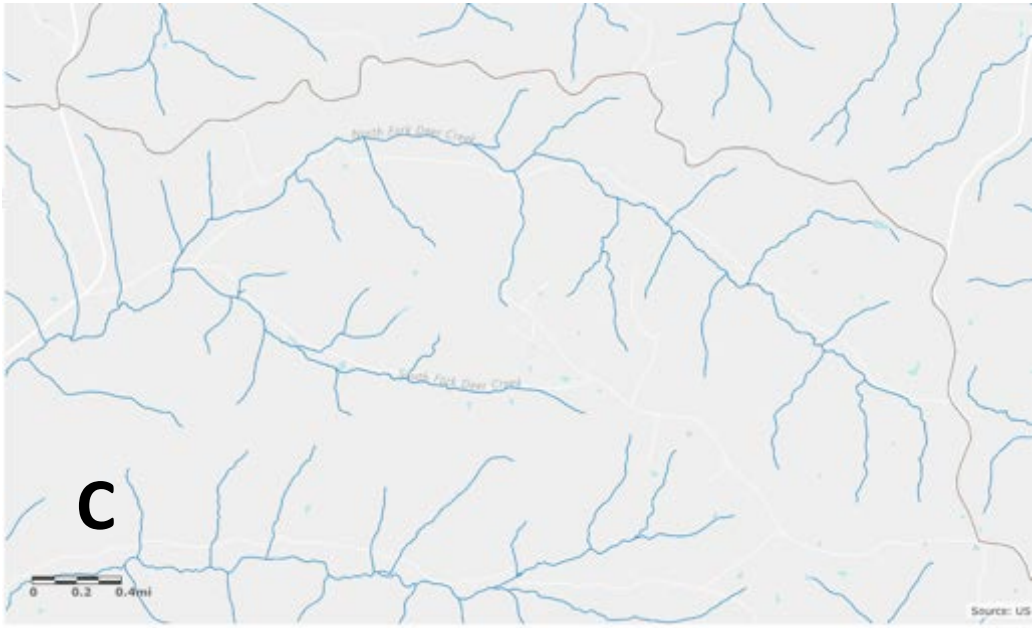
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Letter: _____

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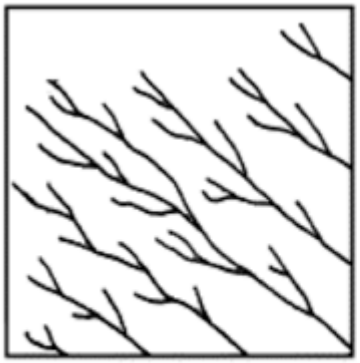

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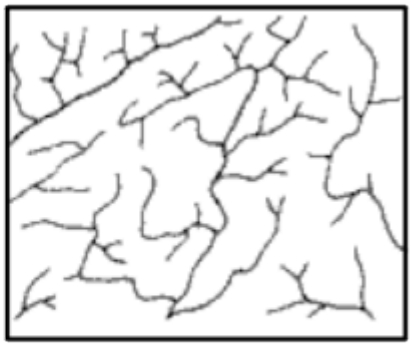

Letter: _____

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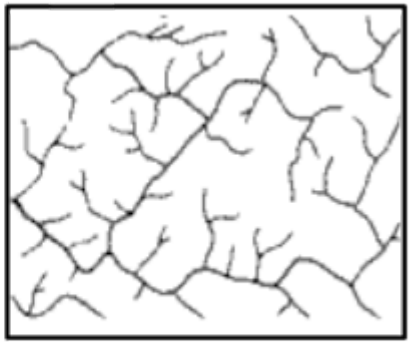

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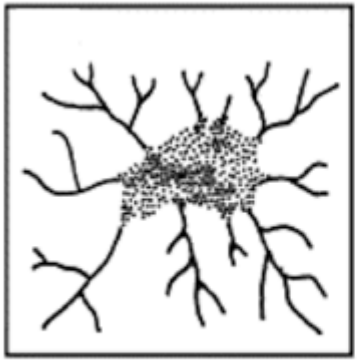


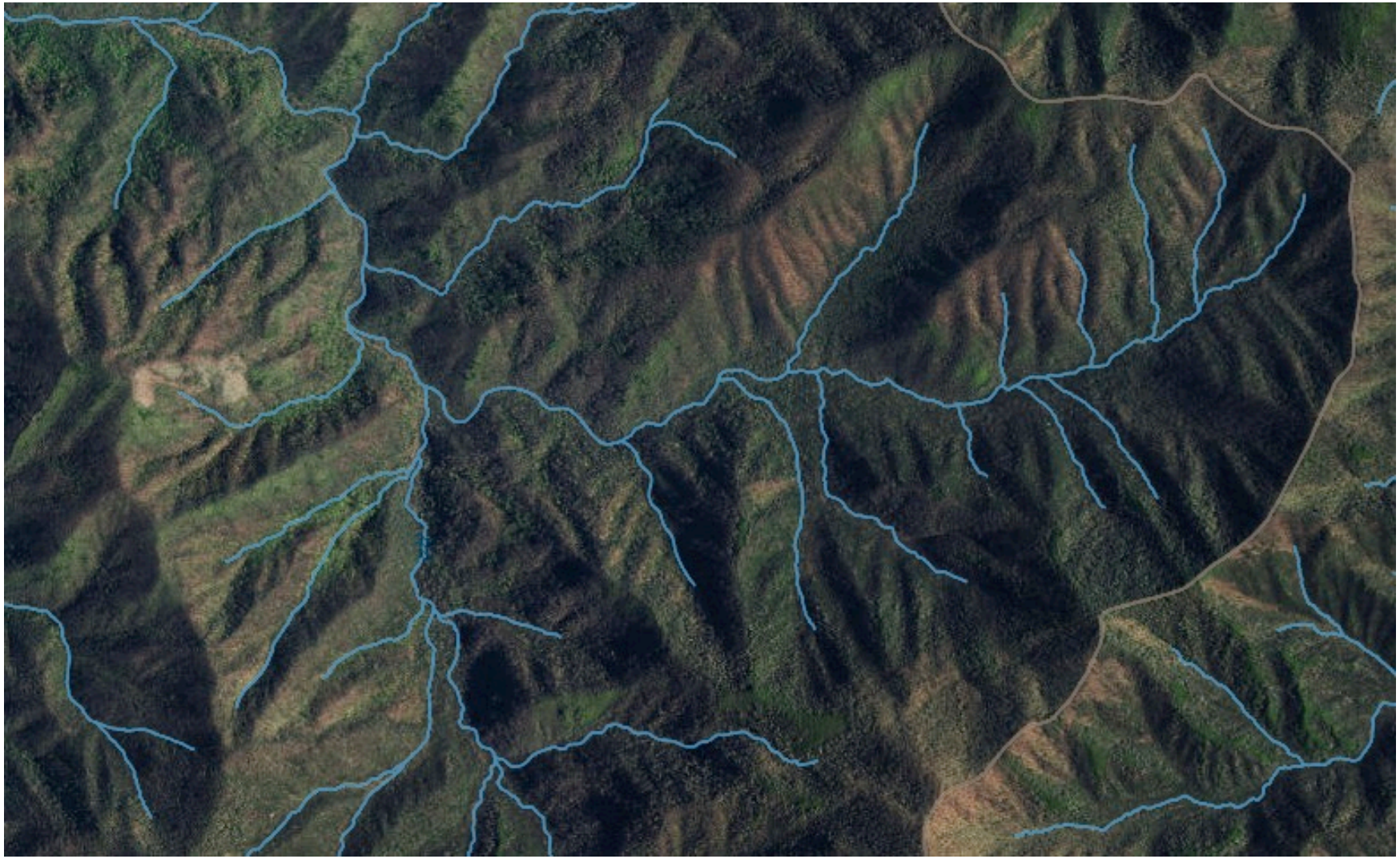
Letter: _____

Sources:

Twidale, C.R. (2004), *Earth-Science Reviews*. Accessed: http://www.sciencedirect.com/science/article/pii/S0012825204000212

and Salaem State: http://w3.salemstate.edu/~lhanson/gls210/gls210_streams3.htm

Part 3 – Competition!



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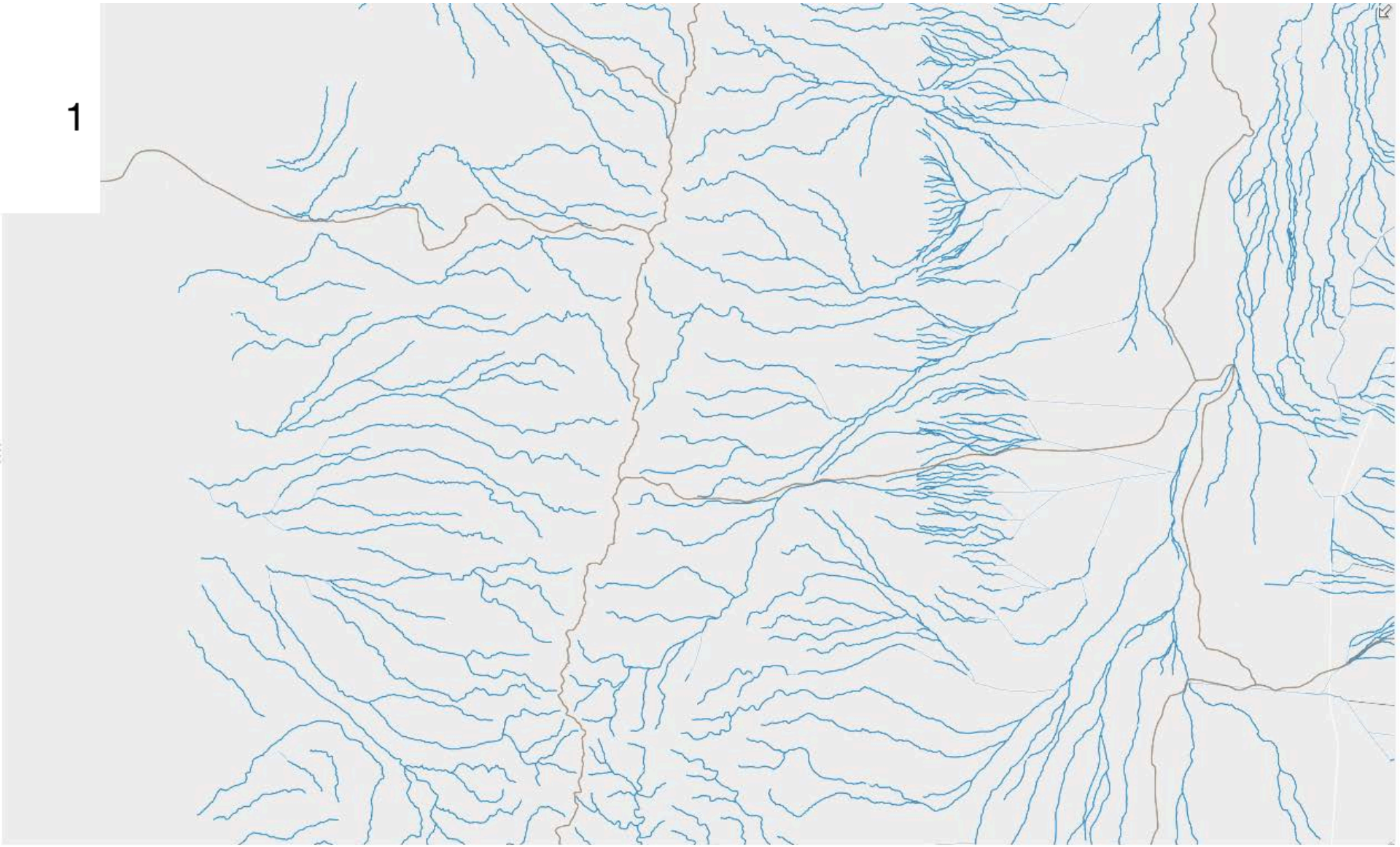

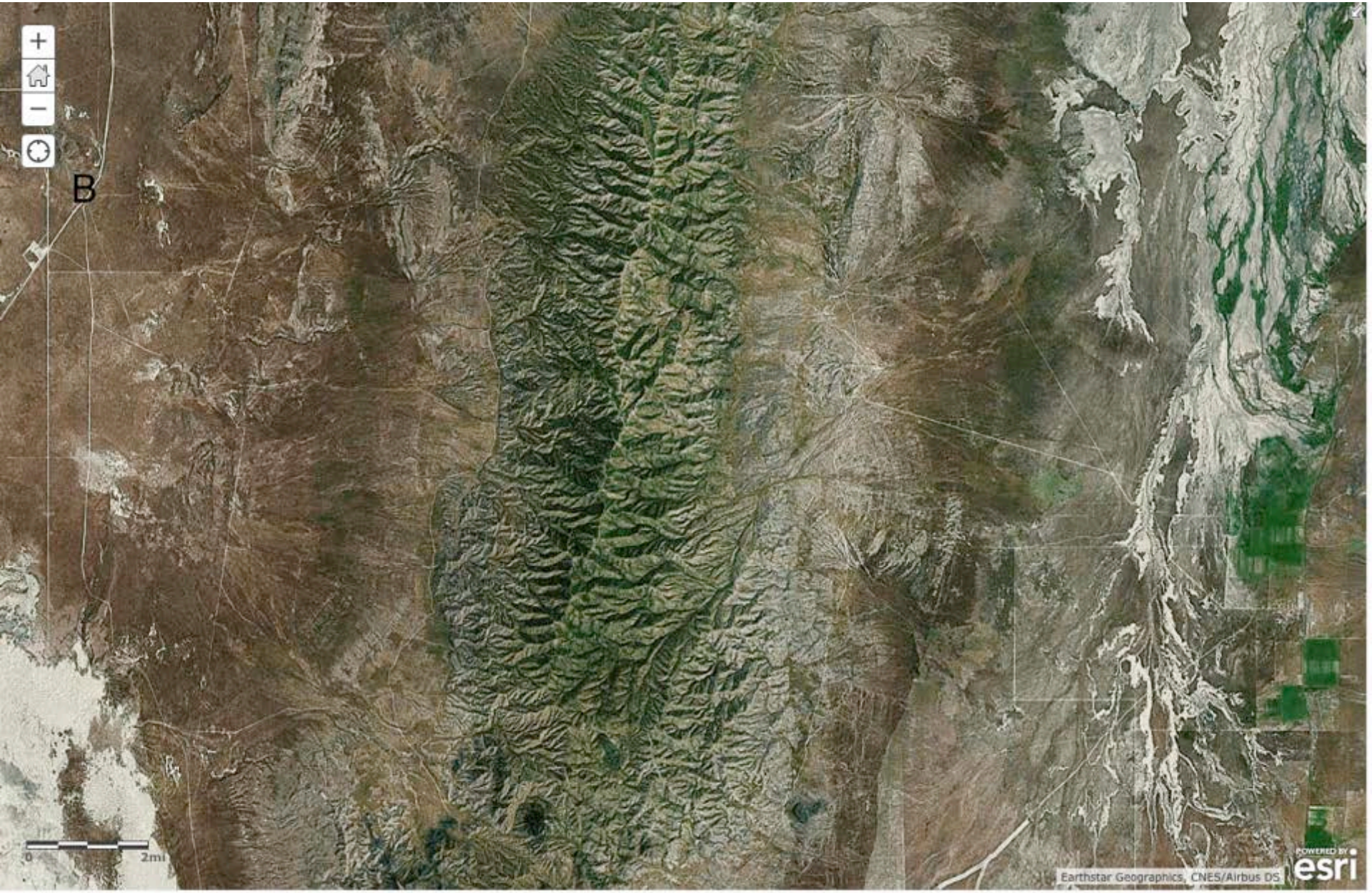
B
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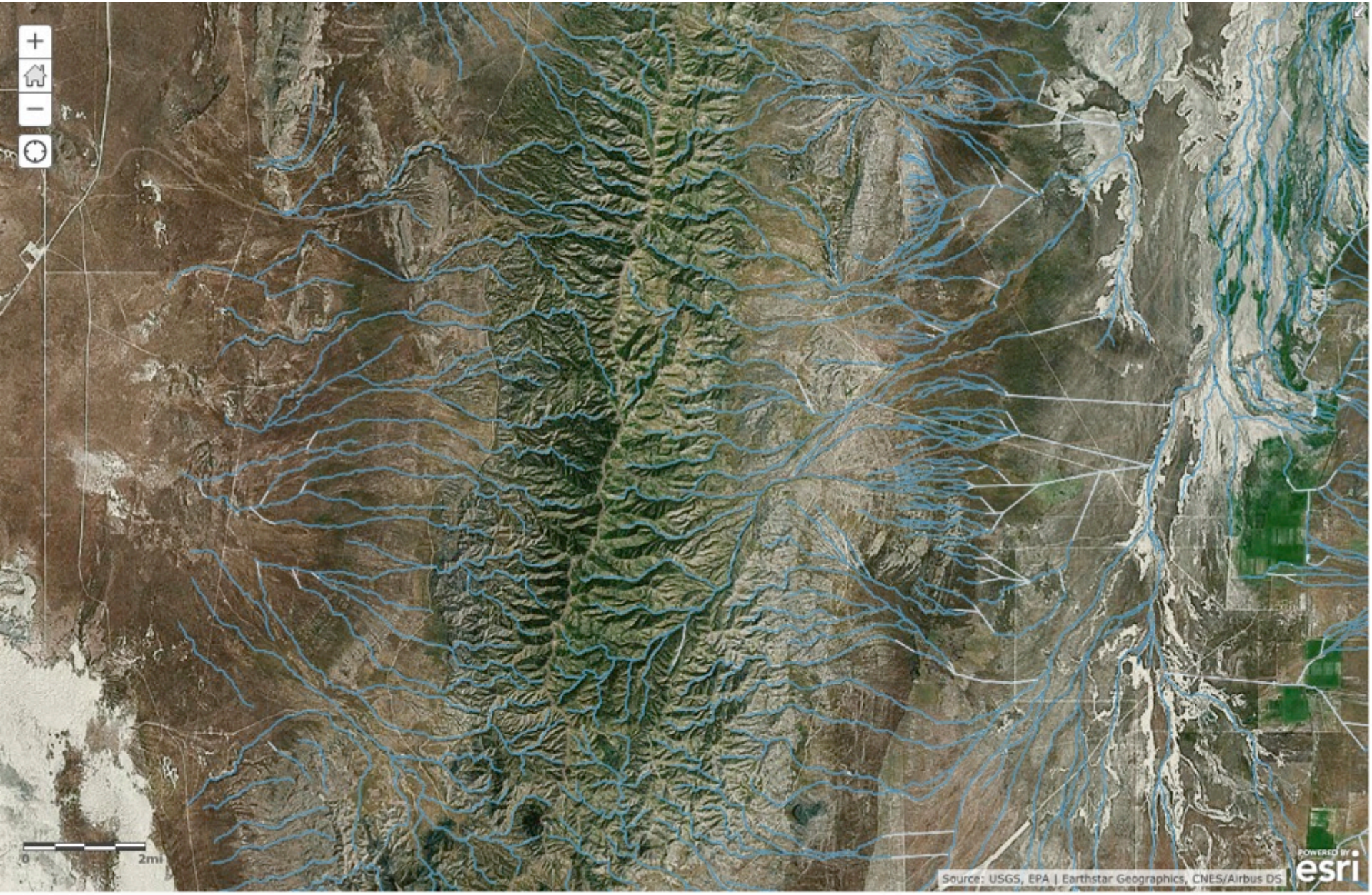
2mi
Earthstar Geographics, CNES/Airbus DS
POWERED BY esri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2mi
Source: USGS, EPA | Earthstar Geographics, CNES/Airbus DS
esri

1B 2F 3I 4D 5A 6J 7N 8G

9M 10C 11H 12L 13E 14K

Sharing Questions

- How did they approach the task? What was the first thing you did in your team?
- What clues did you look for to help make matches? What was the best clue?
- Were there any features or situations that caused confusion or uncertainty and how did you work through it?

Counting Creeks

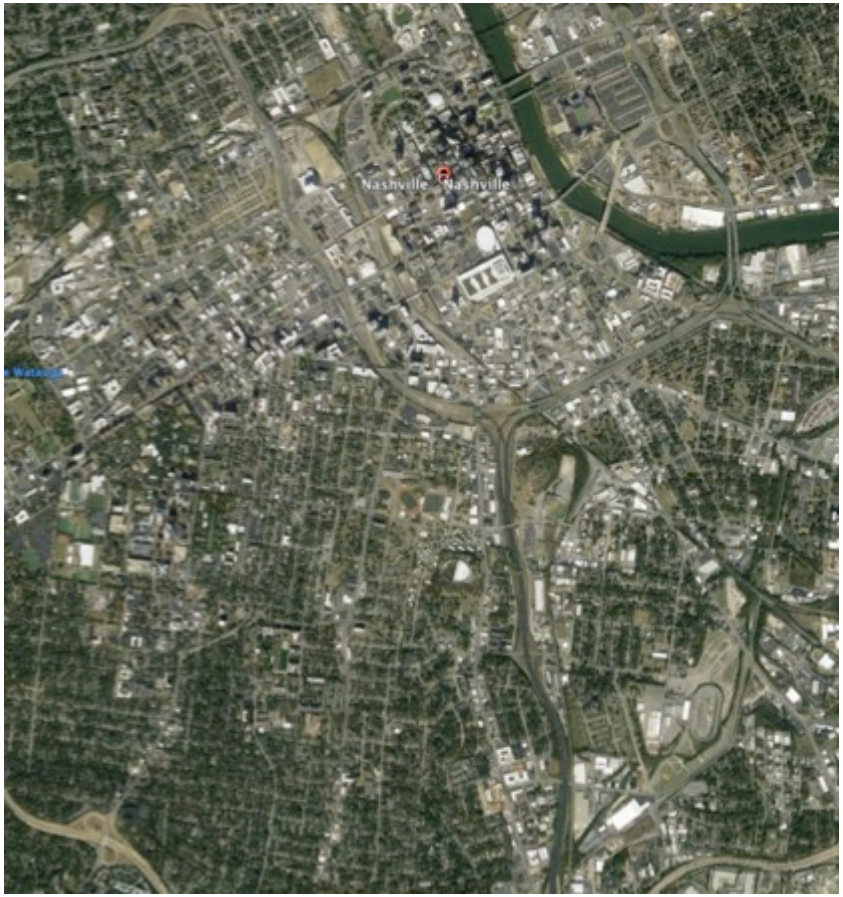
Objectives

- Learn new terminology and explore the concept of density.
- Describe landscape features that factor into drainage density.
- Relate drainage density to the risk of flooding.

New Terminology

- Density – a quantity per unit area or volume.
  - Physical substances (gas, liquid, solids)
  - Tree canopy
  - Populations
- Drainage density – length of water channels (streams, creeks, rivers) per watershed area

Part 1 – Active Analogy Activity



Drainage Density

- Factors affecting drainage density and flooding include:
  - Annual rainfall
  - Soil permeability
  - Topography
  - Land use (runoff)

Part 2 – Calculations!

Counting Creeks

Watersheds

1. Half Pone Creek near Clarksville
Watershed Area = 26.13 mi^2
- 51 inches annual rainfall
- Gently rolling hills
- Moderate soil permeability
- Agriculture

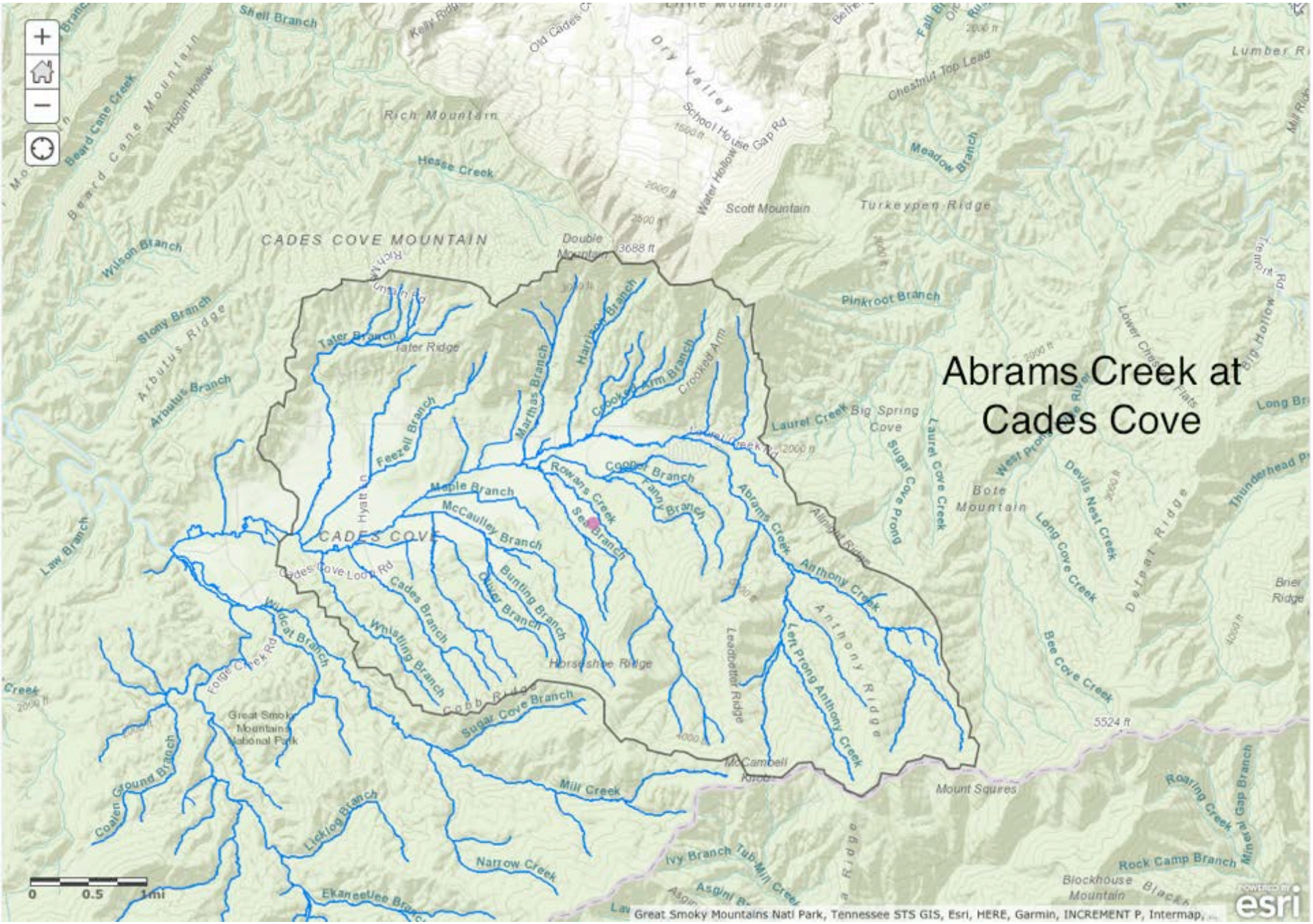
2. Stock Creek at Fort Loudon Lake
Watershed Area = 18.0 mi^2
- 48 inches annual rainfall
- Hilly
- Moderate soil permeability
- Agriculture and Some Forest

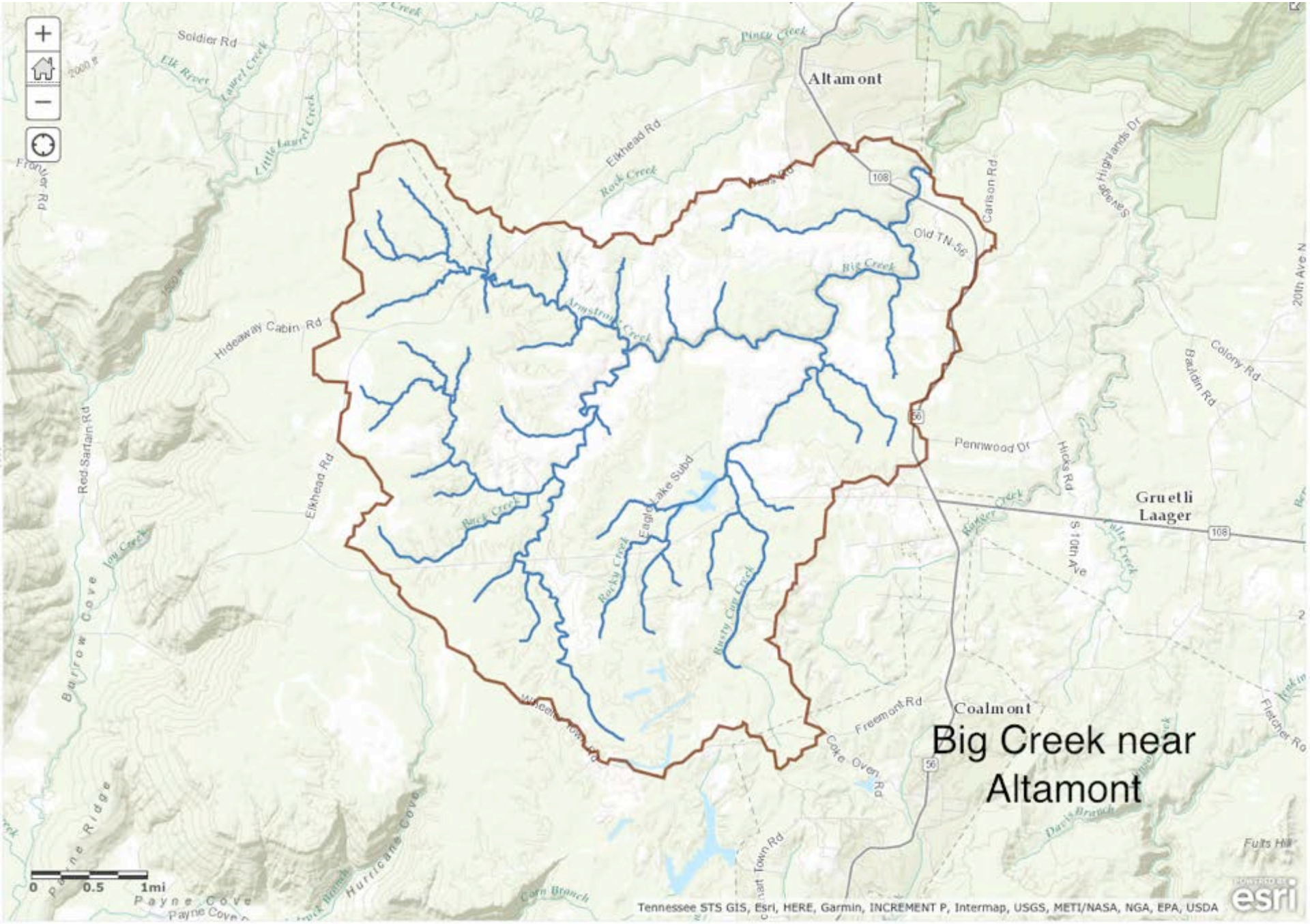
3. Stokes Creek at Tatumville
Watershed Area = 22.8 mi^2
- 52 inches annual rainfall
- Flat
- Low permeability
- Agriculture

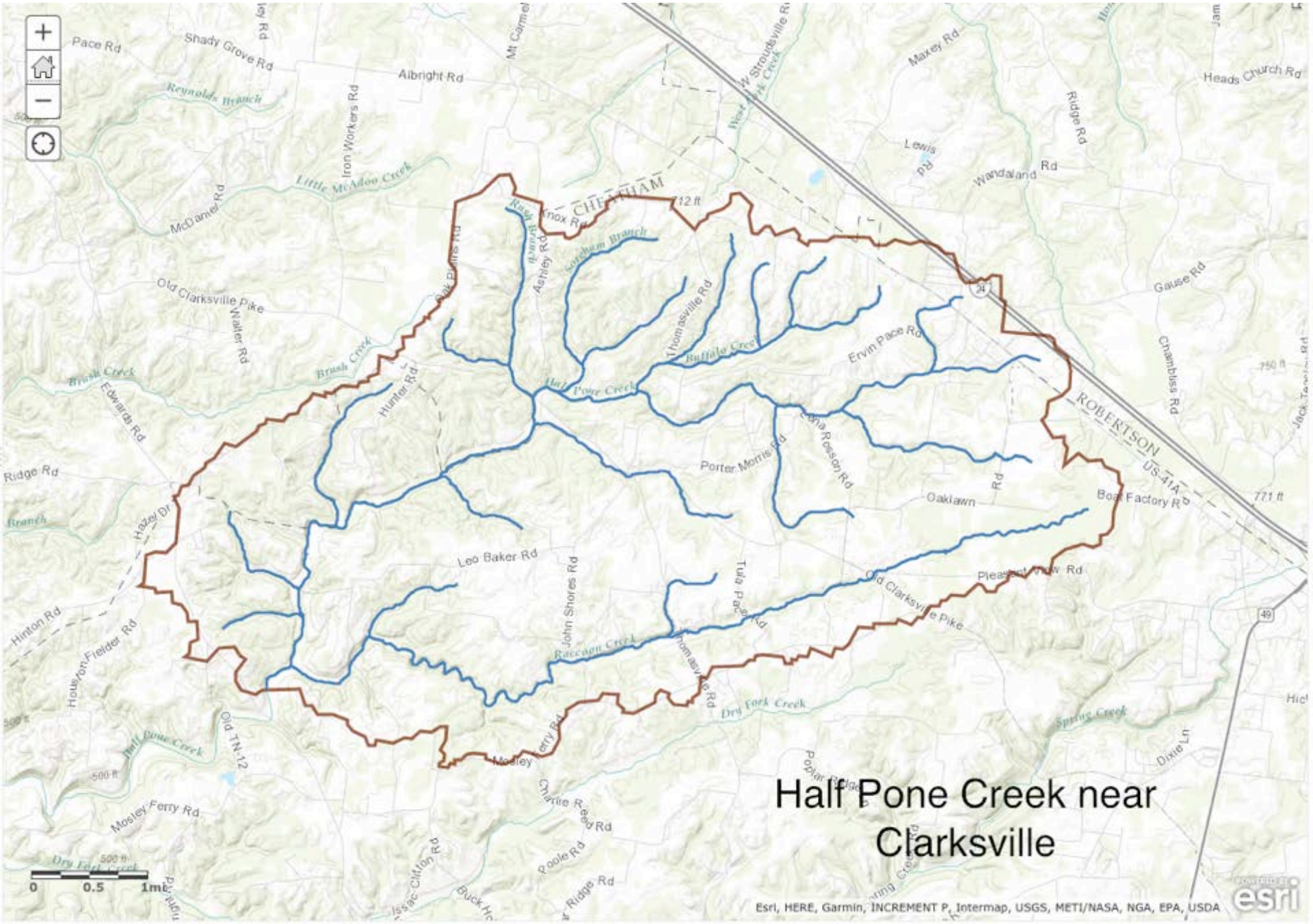
4. Big Creek at Altamont
Watershed Area = 21.02 mi^2
- 58 inches annual rainfall
- Moderately Hilly
- High soil permeability
- Lush forest vegetation

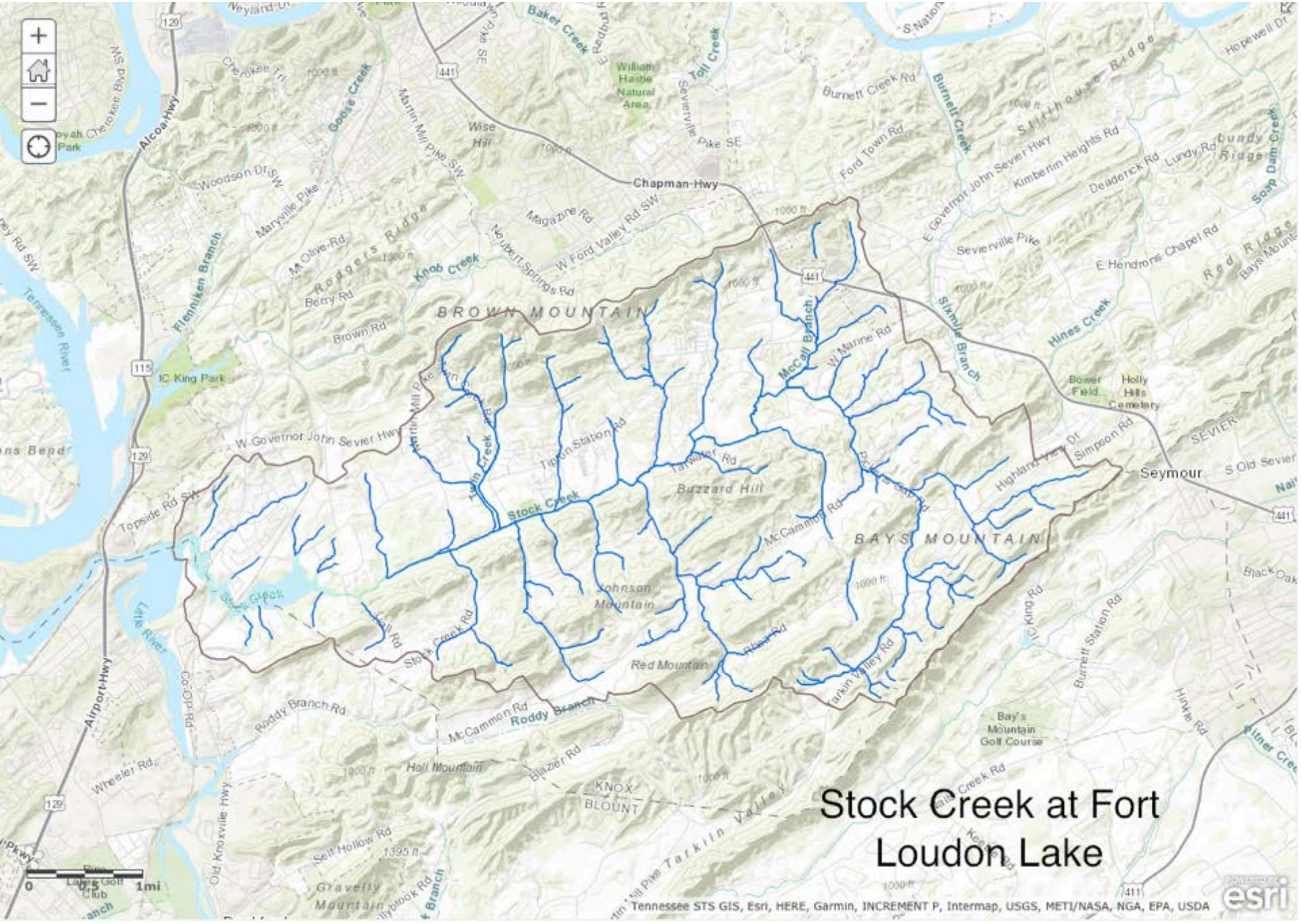
5. Abrams Creek at Cades Cove
Watershed Area = 18.48 mi^2
- 55 inches annual rainfall
- Mountainous
- High soil permeability
- Lush forest vegetation

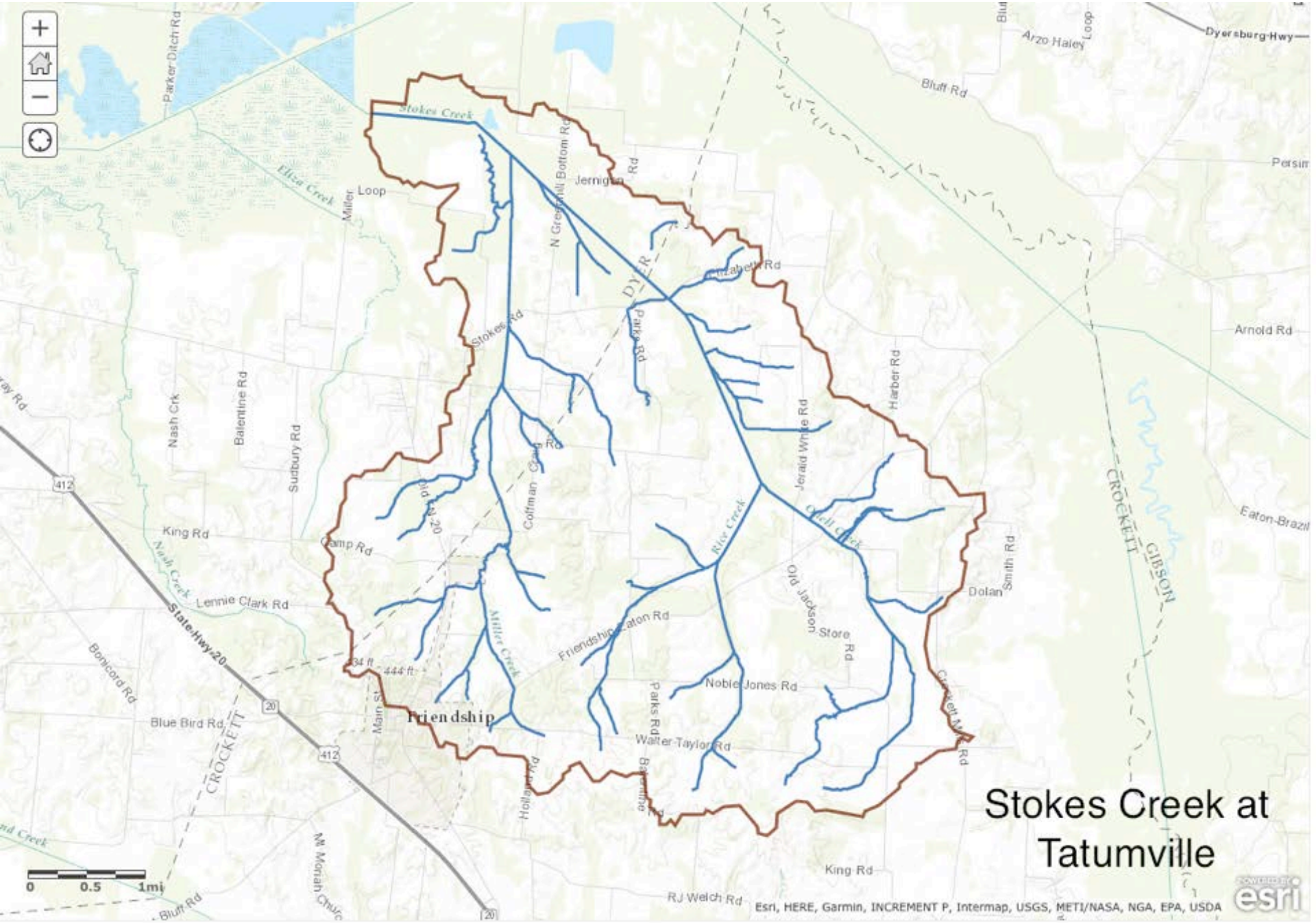
Hypothesize: Consider the creek characteristics and rank them using their creek numbers in order from greatest to least density: ___ ___ ___ ____ ____

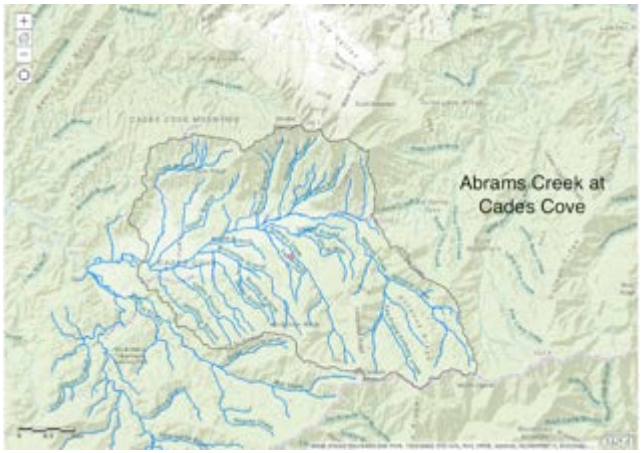

Abrams Creek at Cades Cove
CADES COVE MOUNTAIN
CADES COVE
Rich Mountain
Hesse Creek
Dry Valley
School House Gap Rd
Water Hollow
Scott Mountain
Turkeypen Ridge
Chestnut Top Lead
Meadow Branch
Pinkroot Branch
Double Mountain
3688 ft
Shell Branch
Beard Cane Creek
Beard Cane Mountain
Hogan Hollow
Wilson Branch
Stony Branch
Arbutus Ridge
Arbutus Branch
Tater Branch
Tater Ridge
Feezell Branch
Marthas Branch
Harrison Branch
Crooked Arm Branch
Crooked Arm
Laurel Creek
Big Spring Cove
Laurel Cove Creek
Sugar Cove Prong
Bote Mountain
Long Cove Creek
Devils Nest Creek
Defeat Ridge
Thunderhead Pt
Long Br
Big Hollow
Lower Chestnut Flats
Maple Branch
McCaulley Branch
Rowans Creek
Cooper Branch
Fanny Branch
Sea Branch
Abrams Creek
Anthony Creek
Anthony Ridge
Left Prong Anthony Creek
Leadbetter Ridge
Alinight Ridge
Cades Cove Loop Rd
Cades Branch
Bunting Branch
Oliver Branch
Whistling Branch
Horseshoe Ridge
Cobb Ridge
Sugar Cove Branch
Wildcat Branch
Forge Creek Rd
Great Smoky Mountains National Park
Law Branch
Coalen Ground Branch
Licklog Branch
Mill Creek
Narrow Creek
Ekaneetlee Branch
McCambell Knob
Mount Squires
Bee Cove Creek
Brier Ridge
5524 ft
Roaring Creek
Mineral Gap Branch
Rock Camp Branch
Blockhouse Mountain
Ivy Branch
Tub Mill Creek
Asgini Br
Lumber Ri
Mill Ridge
Tremont Rd
Hyatt Ln
Creek
0
0.5
1mi
Great Smoky Mountains Natl Park, Tennessee STS GIS, Esri, HERE, Garmin, INCREMENT P, Intermap, ...
esri


Big Creek near Altamont
Altamont
Coalmont
Gruetli Laager
Soldier Rd
Elk River
Laurel Creek
Little Laurel Creek
Frontier Rd
Piney Creek
Elkhead Rd
Rock Creek
Carlson Rd
Old TN-56
Big Creek
Armstrong Creek
Hideaway Cabin Rd
Red Sartain Rd
Elkhead Rd
Rock Creek
Eagle Lake Subd
Rocky Creek
Rusty Cup Creek
Penrwood Dr
Hicks Rd
Ranger Creek
S 10th Ave
Colony Rd
Bauldin Rd
Savage Highlands Dr
20th Ave N
Freemont Rd
Coke Oven Rd
Davis Branch
Fletcher Rd
Fults Hill
Burrow Cove
Payne Ridge
Payne Cove
Hurricane Cove
Corn Branch
Wheeler Town Rd
Joy Creek
108
56
0
0.5
1mi
Tennessee STS GIS, Esri, HERE, Garmin, INCREMENT P, Intermap, USGS, METI/NASA, NGA, EPA, USDA
esri


Half Pone Creek near Clarksville
CHEATHAM
ROBERTSON
Pace Rd
Shady Grove Rd
Albright Rd
Reynolds Branch
Iron Workers Rd
Little McAdoo Creek
McDaniel Rd
Old Clarksville Pike
Walter Rd
Brush Creek
Edwards Rd
Ridge Rd
Hazel Dr
Hinton Rd
Houston Fielder Rd
Old TN-12
Half Pone Creek
Mosley Ferry Rd
Dry Fork Creek
Knox Rd
Ashley Rd
Sorcham Branch
Thomasville Rd
Buffalo Creek
Half Pone Creek
Hunter Rd
Leo Baker Rd
John Shores Rd
Raccoon Creek
Mosley Ferry Rd
Charlie Reed Rd
Poole Rd
Issac Clifton Rd
Buck Ho
Porter Morris Rd
Lena Rosson Rd
Tula Pace Rd
Thomasville Rd
Ervin Pace Rd
Oaklawn Rd
Old Clarksville Pike
Pleasant View Rd
Maxey Rd
Lewis Rd
Wandaland Rd
Ridge Rd
Heads Church Rd
Gause Rd
Chambliss Rd
Boat Factory Rd
US-41A
Spring Creek
Dixie Ln
Poplar Ridge
Dry Fork Creek
0 0.5 1mi
Esri, HERE, Garmin, INCREMENT P, Intermap, USGS, METI/NASA, NGA, EPA, USDA
esri


Stock Creek at Fort Loudon Lake
BROWN MOUNTAIN
BAYS MOUNTAIN
Buzzard Hill
Johnson Mountain
Red Mountain
Stock Creek
Twin Creek
McCall Branch
Roddy Branch
Chapman Hwy
Seymour
Tennessee River
Airport Hwy
Alcoa Hwy
Tennessee STS GIS, Esri, HERE, Garmin, INCREMENT P, Intermap, USGS, METI/NASA, NGA, EPA, USDA
0
0.5
1mi


Stokes Creek at Tatumville
Stokes Creek
Eliza Creek
Nash Creek
Miller Creek
Rice Creek
Odell Creek
Friendship
Dyersburg Hwy
Arzo Haley Loop
Bluff Rd
Persim
Arnold Rd
Eaton-Brazil
Parker Ditch Rd
Miller Loop
N Greenhill Bottom Rd
Jernigan Rd
Elizabeth Rd
DYER
Parks Rd
Stokes Rd
Harber Rd
Jerald White Rd
Nash Crk
Balentine Rd
Sudbury Rd
Coffman Craig Rd
Old Hwy 20
King Rd
Camp Rd
Lennie Clark Rd
State Hwy 20
Bonicord Rd
Blue Bird Rd
CROCKETT
Main St
Friendship Eaton Rd
Old Jackson Store Rd
Dolan
Smith Rd
Noble Jones Rd
Walter Taylor Rd
Parks Rd
Holland Rd
Balentine Rd
Mt Moriah Church
King Rd
RJ Welch Rd
Bluff Rd
412
20
0 0.5 1mi
Esri, HERE, Garmin, INCREMENT P, Intermap, USGS, METI/NASA, NGA, EPA, USDA
esri



Abrams Creek

Half Pone Creek

Stock Creek

Big Creek

Stokes Creek

Watershed Densities

1. Half Pone Creek – 42.97 mi / 26.13 mi2 = 1.64
2. Stock Creek – 57.08 mi / 17.97 mi2 = 3.29
3. Stokes Creek – 47.82 mi / 22.80 mi2 = 2.09
4. Big Creek – 45.12 mi / 21.02 mi2 = 2.15
5. Abrams Creek – 69.33 mi / 18.48 mi2 = 3.69

Processing Questions

- Which watershed is most likely to flood?
- Which is least likely?
- What factors affecting flooding do you see around your community?

Stream Math

Objectives

- Describe the concept of stream ordering.
- Use rules to come to an outcome.

New Terminology

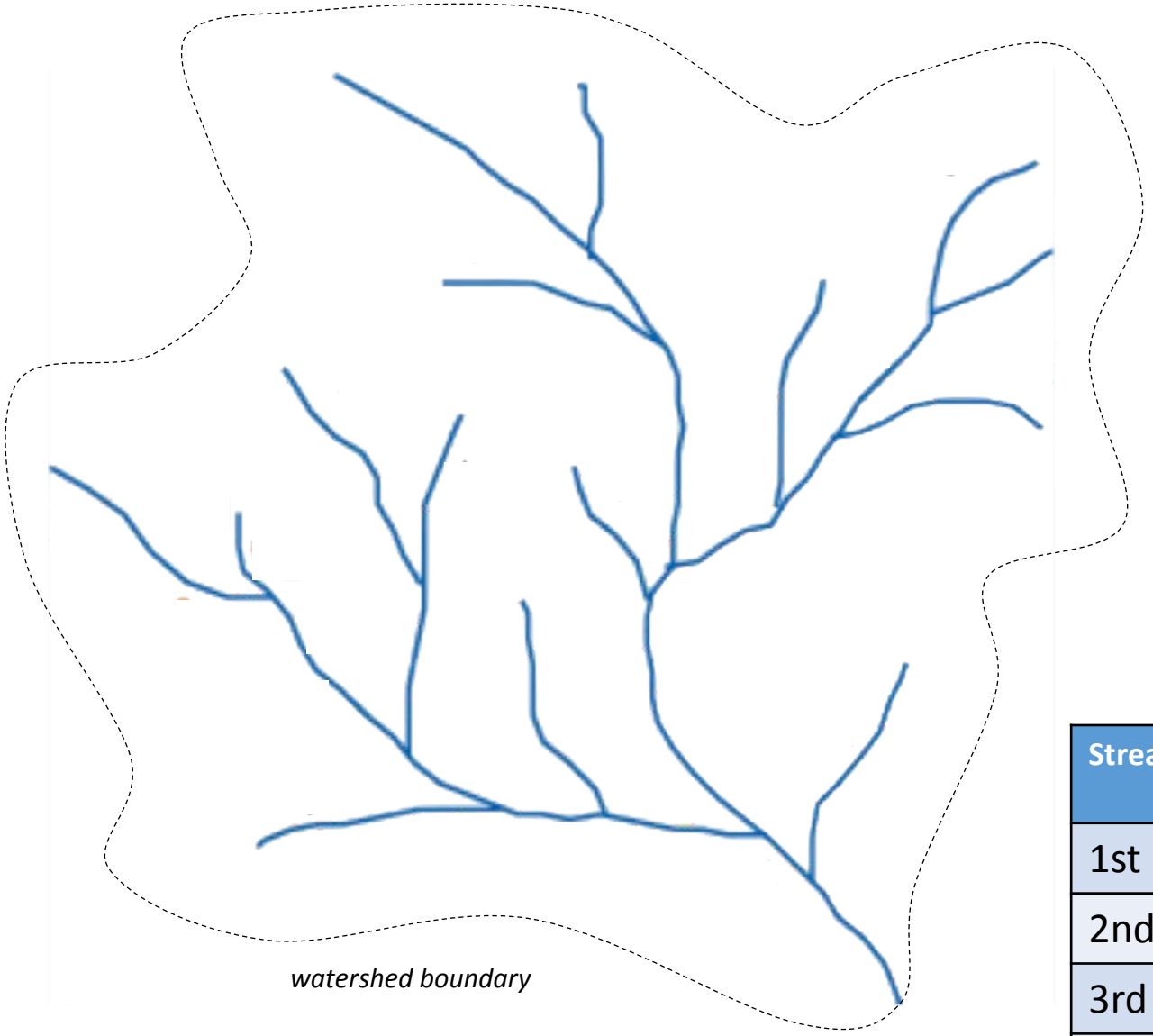
- Stream order – a measure of the relative size of a stream.
- Tributary – a water channel that feeds into a larger water body.
- Converge/Confluence – flow together.
- Fibonacci Sequence – series of numbers that begins with 0 and 1 where the next number is the sum of the previous two.

0 1 1 2 3 5 8 13 21 34 55 89 144 ….

Technology Integration

- www.arcgis.com

Stream Math



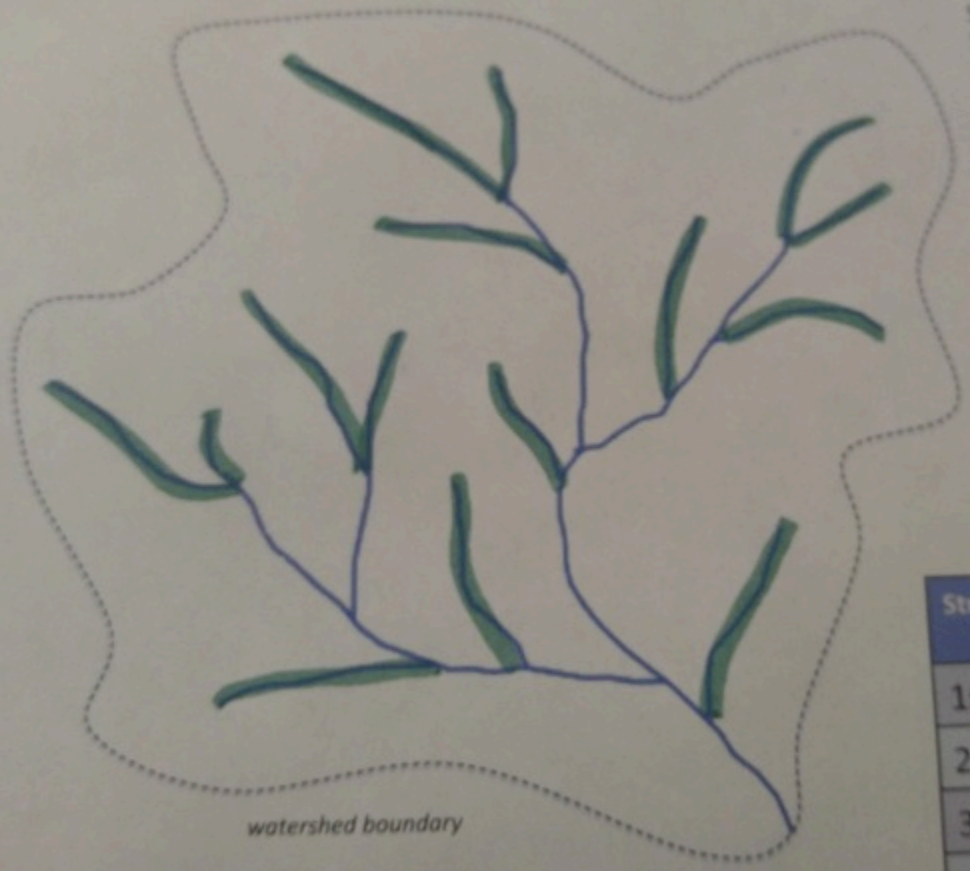
watershed boundary

Stream Math Rules:

1. Begin with the top of the drainages.
2. First order streams are the loose ends.
3. Two streams of the same order converge to create a stream of the next higher order. For example, two 1st-order streams converge and create a 2nd order stream.
4. When a stream converges with a stream of a higher order, it is absorbed by the larger order stream and the order does not change downstream.

Stream Order	# Stream Segments in Order
1st	
2nd	
3rd	
4th	

Stream Math



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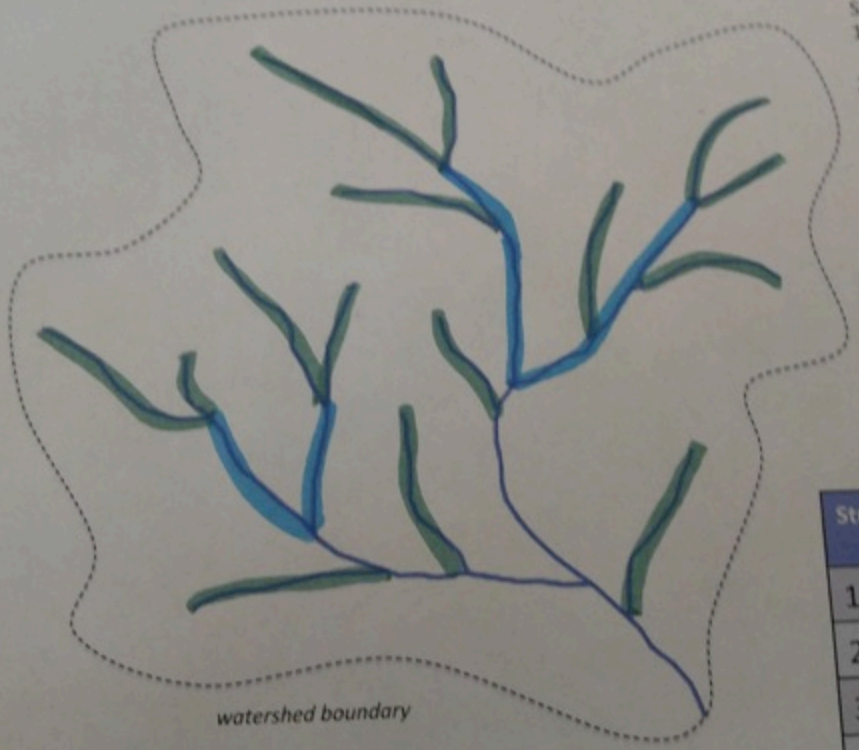
Stream Order	# Stream Segments in Order
1st	
2nd	
3rd	
4th	

Stream Math



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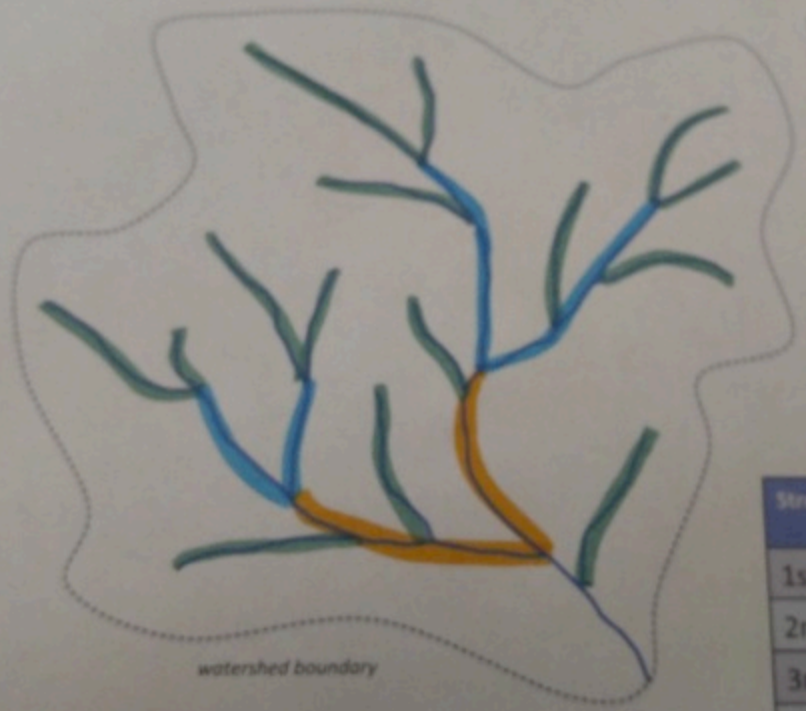
Stream Order	# Stream Segments in Order
1st	
2nd	
3rd	
4th	

Stream Math



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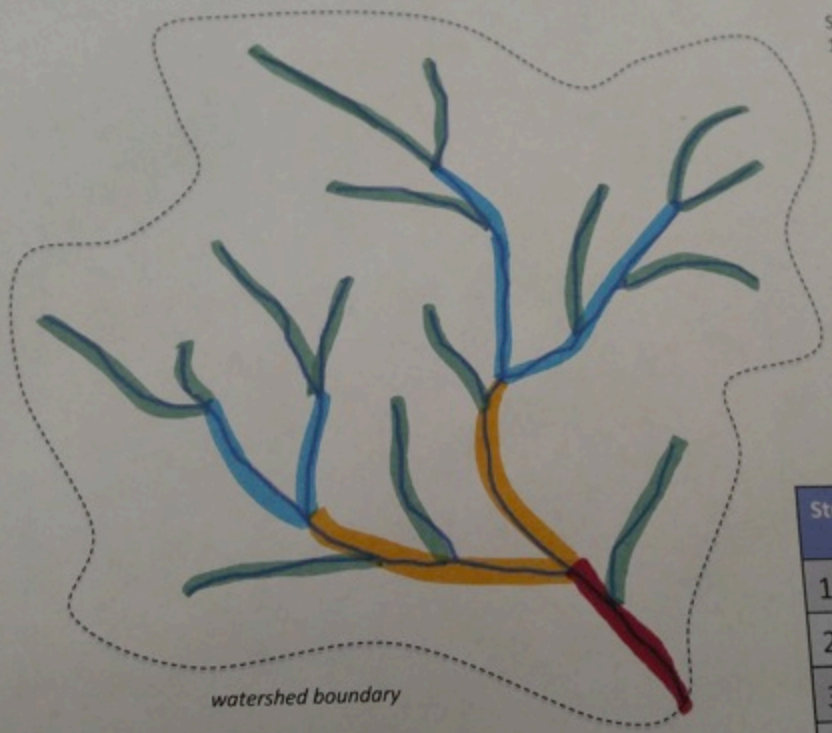
Stream Order	# Stream Segments in Order
1st	
2nd	
3rd	
4th	

Stream Math



Stream Math Rules:

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2. First order streams are the loose ends.
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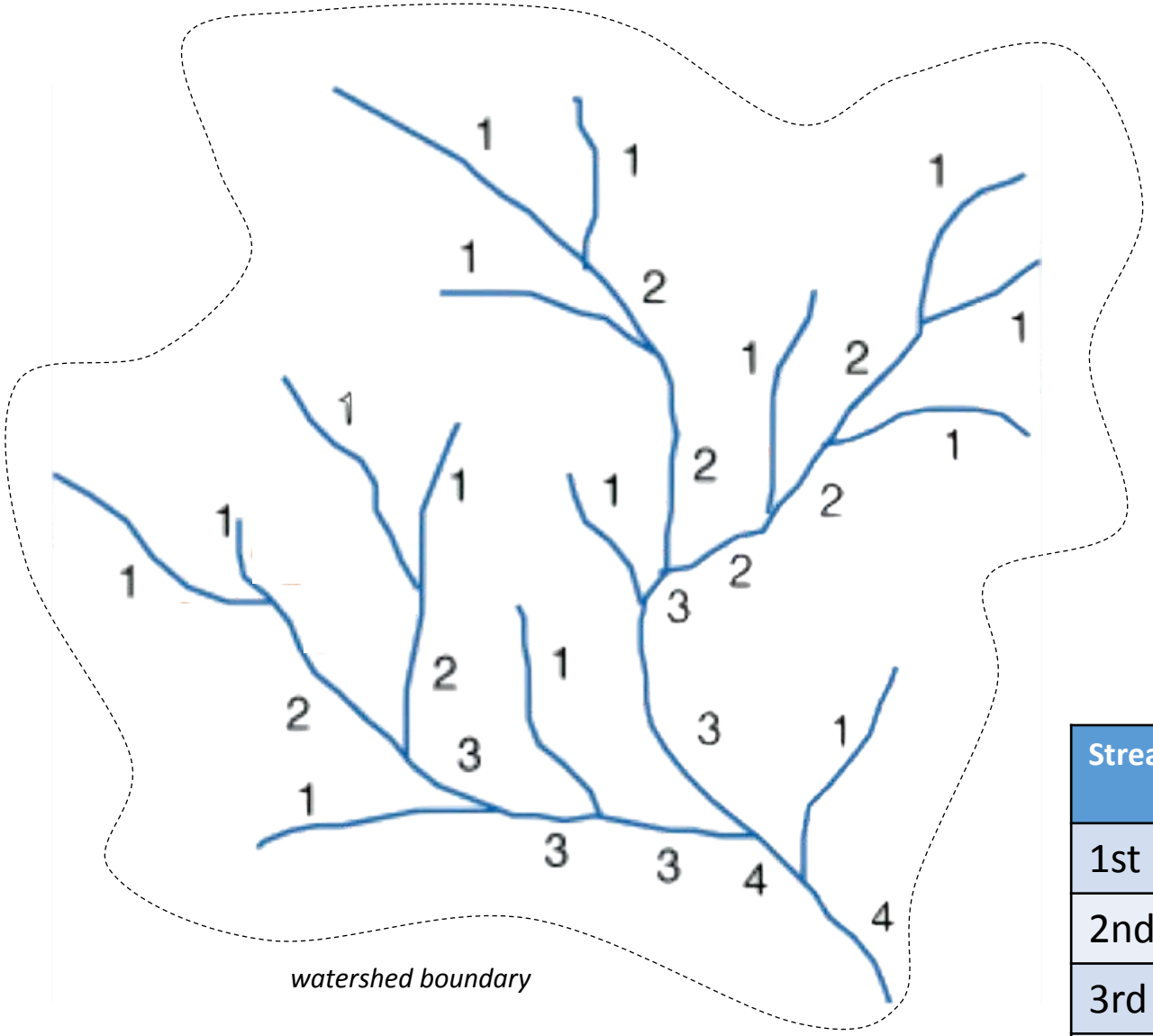
Stream Order	# Stream Segments in Order
1st	
2nd	
3rd	
4th	

Stream Math – solutions



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4. When a stream converges with a stream of a higher order, it is absorbed by the larger order stream and the order does not change downstream.

Stream Order	# Stream Segments in Order
1st	15
2nd	7
3rd	5
4th	2

Additional Resources (added after training sessions)

- Leaf analogy to teach concepts in watersheds (found online after we conducted our training; fits very well!)
  - https://serc.carleton.edu/integrate/workshops/sustainability-action/activities/190419.html

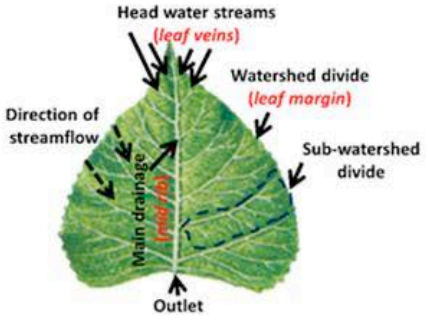
- Rivers Crosswords
  - May choose to remove word banks for a bigger challenge
  - Link to TDOT maps
    - https://www.tn.gov/tdot/driver-how-do-i/look-at-or-order-state-maps/maps/state-maps.html
    - ordering: https://www.tn.gov/tdot/driver-how-do-i/look-at-or-order-state-maps/maps/map-ordering.html

Water Webs Sheets

- The sheets for the water webs matching competition can be found at the link below. Note: the file names do not correspond with the alphanumeric matches. Each drainage web is given a number and each aerial photo a letter, indicated in a textbox on each figure.

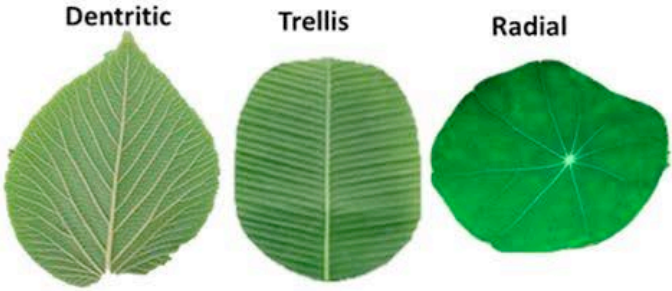
  - **https://tiny.utk.edu/waterwebs**

(a) Learning objective 1

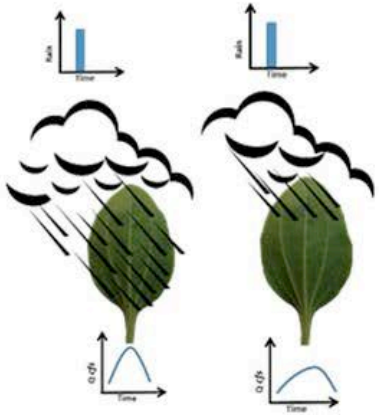


(b) Learning objective 2

(c) Learning objective 2



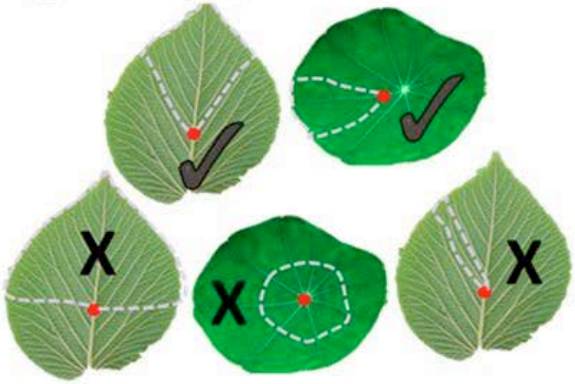
(d) Learning objective 2



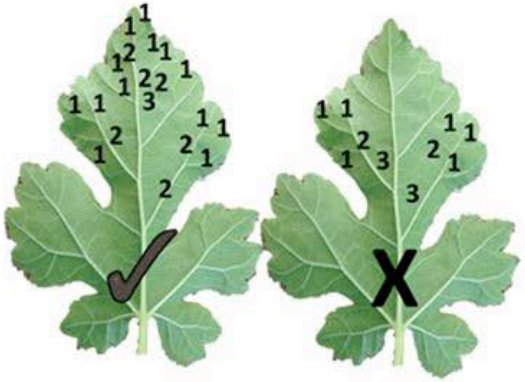
(e) Learning objective 3

(f) Learning objective 3

(g) Learning objective 4



(h) Learning objective 6



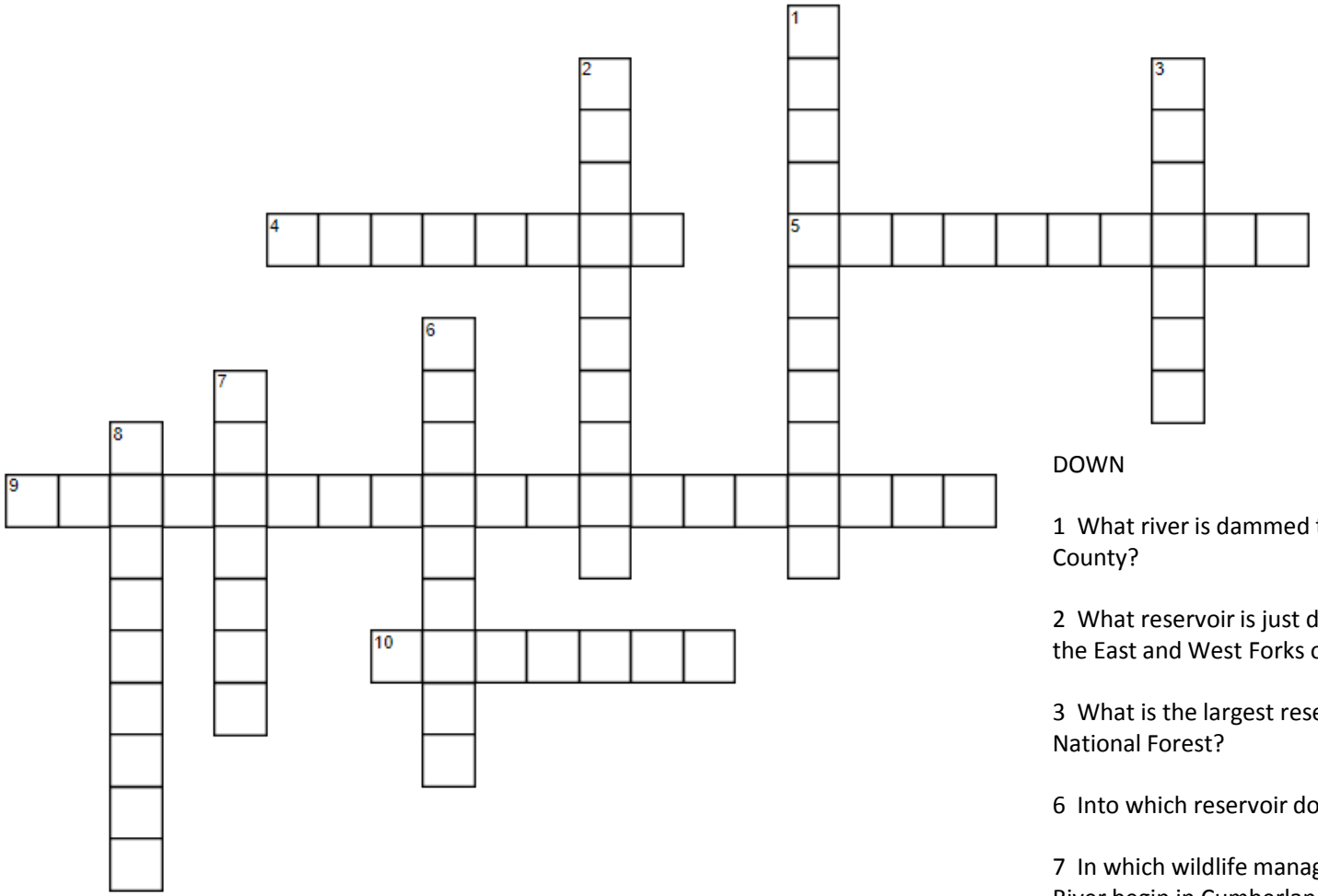
(i) Future work

Source: https://serc.carleton.edu/integrate/workshops/sustainability-action/activities/190419.html

Name _____

Welcome to Tennessee Rivers

East Side



ACROSS

4 What county's southern border lies in the Cherokee Reservoir and Holston River?

5 What river has tributaries of Clear Fork, New River, and Wolf River?

9 Which national park contains the headwaters of the Little River?

10 What is the name of the dam nearest the confluence of the Collins, Rocky, Caney Fork, and Calfkiller Rivers?

DOWN

1 What river is dammed to form Douglas Reservoir in Jefferson County?

2 What reservoir is just downstream from the confluence of the East and West Forks of the Obey River in Pickett County?

3 What is the largest reservoir located entirely in the Cherokee National Forest?

6 Into which reservoir does the Sequatchie River discharge?

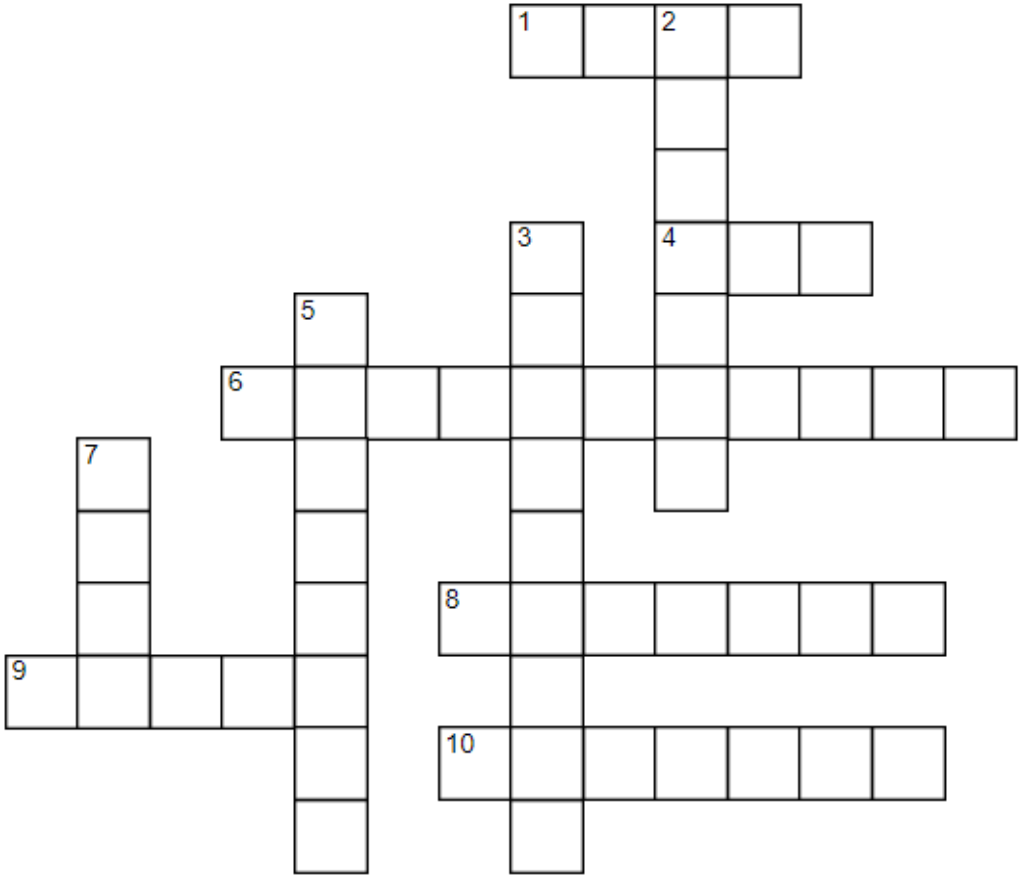
7 In which wildlife management area (WMA) does the Obed River begin in Cumberland County?

8 Which river has the longest distance contained on the map?

WORD BANK: CATOOSA, CUMBERLAND, DALEHOLLOW, FRENCHBROAD, GRAINGER, GREATSMOKYMOUNTAINS, NICKAJACK, TENNESSEE, WALLING, WATAUGA

Welcome to Tennessee Rivers

West Side



ACROSS

1 Which sinuous river in south-central Tennessee has a tributary called the Piney River?

4 What river flows through the city of Clarksville, Tennessee?

6 What river creates the longest stretch of state border in Tennessee?

8 In what county does the Wolf River enter Tennessee from Alabama?

9 What tributary to the Buffalo River begins near the Natchez Trace Parkway?

10 What river begins in Alabama and flows through multiple national wildlife refuges (NWRs)?

DOWN

2 After what tree is the Tennessee State Park named where the South Fork and Middle Fork of the Obion River converge?

3 The Obion and Forked Deer River converge at what National Wildlife Refuge (NWR) before emptying into the Mississippi River?

5 What tributary to Kentucky Lake has its headwaters in Henderson County?

7 Through how many counties doe the North Fork Obion River flow until it reaches the Mississippi River?

WORD BANK: BIGSANDY, CHICKASAW, CYPRESS, DUCK, FAYETTE, FOUR, GREEN, HATCHIE, MISSISSIPPI, RED