

Topo Map Explorer

Adapted from: An original Creek Connections activity.
Creek Connections, Box E, Allegheny College, Meadville, Pennsylvania, 16335

Grade Level: Intermediate

Duration: One class period

Setting: Classroom

Summary: Students review the major concepts of the Topographic Map Module by navigating through a series of scenarios.

Objectives: Students will be able to apply basic topographic map reading skills as well as the concepts of stream order, stream length, stream gradient, general topography, watershed delineation, watershed area, and land use in watersheds to navigate various scenarios involving topographic maps.

Vocabulary: none

Related Module Resources:

- Activities: Stream Order, Stream Length, Stream Gradient, Watershed Delineation, Watershed Area, Land Use in Watersheds, and Topography in Watersheds

Materials (Included in Module):

- Meadville 11x17" laminated quad sections (20)
- Townville laminated full quads (20)
- USGS Topographic Map Symbols (*Please return with module!*)
- Map wheels/string
- Wet erase markers
- Calculators
- Topo Map Explorer Worksheet and Answer Key with figures
- 1 Planimeter
- Blank overhead transparencies
- Reproducible graph paper

Additional Materials (NOT Included in Module):

- Moist and dry paper towels
- Rulers
- Balance

ACADEMIC STANDARDS:

ENVIRONMENT & ECOLOGY

7th Grade

- 4.1.7.B. Understand the role of the watershed.
- Identify and explain what determines the boundaries of a watershed.
- 4.3.7.B. Describe how human actions affect the health of the environment.
- Identify land use practices and their relation to environmental health.
- 4.8.7.C. Explain how human activities may affect local, regional and national environments.
- Explain how a particular human activity has changed the local area over the years.

10th Grade

- 4.1.10.A. Describe changes that occur from a stream's origin to its final outflow.
- Describe changes by tracing a specific river's origin back to its headwaters including its major tributaries.
- 4.1.10.B. Explain the relationship among landforms, vegetation and the amount and speed of water.
- Delineate the boundaries of a watershed.
- 4.1.10.E. Identify and describe natural and human events on watersheds and wetlands.
- Identify the effects of humans and human events on watersheds.
- 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.A. Categorize stream order in a watershed.
- Explain the concept of stream order.
 - Identify the order of watercourses within a major river's watershed.
 - Compare and contrast the physical differences found in the stream continuum from headwater to mouth.
- 4.1.12.E. Evaluate the trade-offs, costs and benefits of conserving watersheds and wetlands.
- Evaluate the effects of human activities on watersheds and wetlands.

GEOGRAPHY

6th Grade

- 7.1.6.A. Describe geographic tools and their uses.
- Geographical representations to display spatial information: topography
 - Basic spatial elements for depicting the patterns of physical and human features: point, line, area, location, distance, scale
- 7.2.6.A. Describe the physical characteristics of places and regions.
- Components of Earth's physical systems (e.g., relief and elevation (topography))
 - Comparisons of the physical characteristics of different places and regions (e.g., topography)

9th Grade

- 7.4.9.B. Explain the impacts of people on physical systems
- Forces by which people modify the physical environment (e.g., increasing population; new agricultural techniques; industrial processes and pollution)

12th Grade

- 7.2.12.A. Analyze the physical characteristics of places and regions including the interrelationships among the components of Earth's physical systems.
- Watersheds and river basins

BACKGROUND:

By doing the other activities in this Topographic Map Module, students have learned how to read basic topographic map colors and symbols, how to read contour lines and general topography, how to determine stream order, stream length, and stream gradient, as well as how to delineate and find the area of watersheds and identify the different land uses in those watersheds. These topics have been presented singly although connections among them have been made as often as possible. In reality, however, these topography skills are used in conjunction with one another instead of singly. If your classes have pursued any of the extension ideas that suggest contacting local environmental professionals to research how they use topography in their daily work, they may have realized that these environmental professionals employ numerous topographic map skills to solve single problems. This activity seeks to replicate that experience by encouraging students to apply multiple topographic map skills to navigate through various scenarios. Creek Connections hopes that this activity, therefore, will serve as an excellent review of the material presented in this module.

OVERVIEW:

Students apply their topographic map skills, including reading topographic map symbols, colors, contour lines, and topography, determining stream order, stream length, and stream gradient, delineating and finding the area of watersheds, and identifying the land uses in watersheds and predicting how those land uses might be affecting water quality, to complete five scenarios on a worksheet.

PROCEDURE:

Teacher Preparation:

1. Make copies of the Topo Map Explorer Worksheet for your students.
2. Locate the Meadville and Townville laminated partial quads, wet erase markers, map wheels, and calculators in the module.
3. Select the method(s) you'd like your students to use to determine the watershed area in question 3a. and gather the appropriate materials for each station (refer to the table below).
4. Using the table below as a guide, set up seven stations around the classroom—one for each of the seven questions, with the materials necessary to complete that question (and maybe a few extra pieces of equipment so that students have to select the appropriate materials). The moist and dry paper towels are for wiping off the laminated quads for the next student to use.

Question/Station #	Required Materials
1	Meadville laminated 11x17" quad sections, USGS document <u>Topographic Map Symbols</u> and/or "Common Topographic Map Colors & Symbols" key, map wheel/string, ruler, calculator
2	Meadville laminated 11x17" quad sections
3	Meadville laminated 11x17" quad sections, USGS document <u>Topographic Map Symbols</u> and/or "Common Topographic Map Colors & Symbols" key, map wheel/string, ruler, calculator
4	Meadville laminated 11x17" quad sections, map wheels/string, calculators, wet erase markers, watershed area materials (depends on the method you want your students to use), moist and dry paper towels
5	Townville laminated full quads, wet erase markers, moist and dry paper towels
6	Townville laminated full quads, wet erase markers, USGS document <u>Topographic Map Symbols</u> and/or "Common Topographic Map Colors & Symbols" key, moist and dry paper towels
7	Townville laminated full quads, wet erase markers, USGS document <u>Topographic Map Symbols</u> and/or "Common Topographic Map Colors & Symbols" key, moist and dry paper towels

Student Activity:

1. Briefly review the major topics that have been covered in the Topographic Map Module, including reading topographic map colors, symbols, contour lines and topography, determining stream order, length, and gradient, delineating and determining the area of watersheds, and land use in watersheds.
2. Distribute worksheets to students.
3. Divide students into five groups and assign each group to a station.
4. Instruct them to use the materials at the station to complete the corresponding question. You may want to encourage them to use notes and/or handouts (especially the USGS document, Topographic Map Symbols) and worksheets from previous activities to refresh their memories about the procedures associated with different topographic map topics.
5. Give students approximately ten minutes to work through each question, and then have them switch to a new station. If they need more time at a particular station, allow them to stay at that station until they have completed the question or to return to it after they have completed the other questions.
6. Go over the correct answers with students.

DISCUSSION:

How does one determine the distance between two points using topographic maps? *One uses a map wheel or string to measure the distance in inches (or centimeters) on the map and then uses the scale to convert this measurement to actual miles (or kilometers).*

How can you determine the direction of the flow of runoff from a given point on a topographic map? *Runoff flows downhill, perpendicular to contour lines.*

What are some of the major colors on topographic maps and how are they related to land use effects on nearby waterways at a given site on a topographic map? *Green areas are woods or forests or reforested areas. Green areas along waterways probably represent riparian buffers, which are beneficial to waterways. White areas indicate cleared land. These areas have few or no trees and might have been cleared for cropland, pastureland, lawns, athletic fields, golf courses, industrial lands, or wetlands etc. In Western Pennsylvania, white areas most commonly denote agricultural land. Cleared areas might be more susceptible to soil erosion and thus contribute excess sediment in runoff to waterways. Cleared land along streams indicates the absence of streamside buffers and all of the advantages associated with them (shade, cooler water temperatures, high dissolved oxygen, slow down, absorb, and filter runoff, sequester nutrients, etc.) Light pink-shaded regions are densely built-up, more urbanized areas. There are so many buildings and man-made structures in these areas that it is impossible to depict each of them individually. Instead, the entire area is shaded light pink. Light pink areas probably have a lot of impermeable surfaces (roads, sidewalks, etc.) that would not be able to absorb runoff and could even heat the runoff in warmer months. This warm runoff could increase the temperature of the waterways it drains into. Individual man-made features are black. Brown is used mainly for contour lines, which indicate elevation and are helpful when delineating watersheds. And bright pink/purple highlights features that have been added to the map since its last edition. Blue areas on topographic maps represent water: creeks, streams, rivers, ponds, and lakes.*

What is a drumlin? *A drumlin is a specific type of hill that is rounded at one end and more pointed at the other.*

In general, what is the relationship between stream order and stream length? Stream order and stream gradient? Stream order and watershed area? *Streams of order n are approximately twice as long as stream of order n-1. Low order streams generally have steeper stream gradients than higher order streams. Watersheds of order n are approximately five times as large (have five times the area) as streams of order n-1.*

EVALUATION:

- Students have correctly completed the worksheet.
- Discussion questions above.
- Create new scenarios with which to test your students.

EXTENSIONS AND MODIFICATIONS:

- Have students create their own scenarios to lead their classmates to buried treasure or a ravine with endangered salamanders in it, etc.
- Have students plan hypothetical hiking excursions of a given length that pass through areas of specific elevation and land use e.g., a 5-mile (8.1 km) hike that includes ascending 1,000 feet (305 m), passes along a second order stream, and goes through a section of cleared land.

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



WORKSHEET : TOPO MAP EXPLORER

Name _____ Class _____

Meadville Quad (Use laminated 11x17" quad sections)

1. Start at the Bethesda Home for Children and hike along the 1350 contour line heading west until you reach the headwaters of a named intermittent tributary of French Creek.

a.) What is the name of the ravine in which this tributary flows?

Follow the streambed to the point where it meets the railroad tracks. Hike 0.25 miles directly east.

b.) What is the land use at this location? _____

c.) What effects might this land use have on the water quality of French Creek?

d.) How might the land use immediately next to French Creek mitigate (reduce) the effects of the land use described in b.) above?

2. One of your friends stands on top of "Round Top" and claims that this hill has a very special name given to it because one side is more rounded while the other side is more pointed.

a) What type of hill is "Round Top"? _____

Your friend standing on "Round Top" claims that he/she is at a higher elevation than anywhere else on this topographic map and challenges you to find another spot that is higher in elevation.

b) Will you win the challenge? Explain. _____

Your friend standing on "Round Top" then claims that he is standing on the steepest hill on the topographic map.

c) Would you agree? How did you use the topographic map to determine this?

3. a.) Where is the lowest point in elevation on this topographic map quad?
(Hint: Where does all the water on this map drain to eventually?).

Start at this point, travel west uphill.

- b.) Is this hill wooded or cleared? _____

Continue traveling west until you reach a major telephone line. Follow the telephone line downhill.

- c.) What direction are you traveling now? _____

Follow this telephone line until it crosses the first light duty road.

- d.) What is the elevation of this road under the telephone line (call this Point A)?

- e.) From this Point A, how many miles away is the nearest wetland?

- f.) From this Point A, how many miles away in a straight line is the Crawford County Courthouse in Diamond Park? _____

4. Put your canoe into French Creek where a light duty road crosses the Creek just south of Saegertown and north of the State Public Access Area. Canoe one mile downstream.

- a.) What is the length from headwaters to mouth of the small, intermittent stream that enters French Creek at this point? _____

- b.) How many total vertical feet does this stream drop from headwaters to mouth?

- c.) On average, how many vertical feet does this stream drop per unit horizontal distance, i.e. what is the average stream gradient?

- d.) Is the stream gradient in c.) above steeper or more gradual than the stream gradient of the next small intermittent stream downstream?

- e.) What is the watershed area of the stream in question a.)? _____

Townville Quad (*Use laminated full quads.*)

5. Start at the flagpole at the “High School” building in Townville.

- a.) What is the elevation at this point? _____

Follow the path of runoff from the flagpole down the hillside to where it drains into a waterway. Let’s call this Point B.

- b.) What is the name of this waterway? _____

- c.) What is the approximate elevation of this waterway at Point B? _____

- d.) What is the elevation difference between the flagpole at the “High School” and this waterway at Point B? _____

- e.) What is the stream order of this waterway at Point B? (Note: consider intermittent as well as perennial tributaries for this exercise.) _____

6. Start at BM 1212 near the intersection of Dewey and Three Bridges Road. Hike upstream along the small intermittent stream that has no tributaries until you reach the headwaters.

a.) What is the elevation of the headwaters? _____

b.) What is unique about the headwaters of this stream? _____

Now continue hiking directly west until you arrive at the second 1450 feet contour interval line. Trace the flow of runoff from this point all the way until it flows into a stream.

c.) Follow this stream downstream and write down the various land uses that the stream flows through. _____

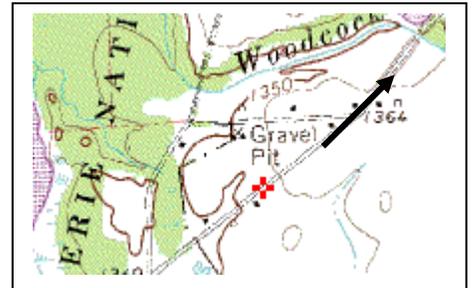
d.) Determine the stream order for this small creek at its mouth. Consider intermittent and perennial tributaries for this exercise. _____

e.) What is the name of the waterway that this small stream empties into? _____

7. Woodcock Creek is one of the main streams on this topographic map quad.

a.) If you were unfamiliar with this waterway and area, how could tell on the topographic map whether Woodcock Creek flows NORTH or SOUTH through the Erie National Wildlife Refuge?

In addition to Woodcock Creek, Muddy Creek is another large creek on this topographic map. You might have learned that large creeks often have large watersheds. The Woodcock Creek and the Muddy Creek watersheds border each other. Find the section of the topographic map shown to the right on your topographic map (near the Erie National Wildlife Refuge). Start on the mark shown to the right, travel along the light duty road northeast (as indicated by the arrow direction). Continue to travel this road, and find the exact place along this road that is the watershed boundary between the Muddy Creek and Woodcock Creek Watersheds.



b.) Describe its location in detail here: _____

c.) What kind of land use exists at this location? _____



ANSWER KEY : TOPO MAP EXPLORER

Meadville Quad (Use laminated 11x17" quad sections)

1. Start at the Bethesda Home for Children and hike along the 1350 contour line heading west until you reach the headwaters of a named intermittent tributary of French Creek.

a.) What is the name of ravine in which this tributary flows? ***Shellhammer Hollow***

Follow the streambed to the point where it meets the railroad tracks. Hike 0.25 miles directly east.

b.) What is the land use at this location? ***Gravel pit***

c.) What effects might this land use have on the water quality of French Creek?

The vegetation at this site has probably been stripped away, leaving the land more susceptible to soil erosion. This soil could be carried in runoff to French Creek, increasing its turbidity and adversely affecting aquatic life. This turbidity would absorb more heat and increase water temperatures. Warmer waters hold less dissolved oxygen. In addition to soil in the runoff from the site, they might also be metals and minerals from the crushed rock, which would increase TDS.

d.) How might the land use immediately next to French Creek mitigate (reduce) the effects of the land use described in b.) above?

French Creek is buffered from the gravel pit with riparian (streamside) forest buffer, which would protect the stream from the adverse effects listed above. The buffer would slow down and absorb runoff and filter out sediment and potentially dissolved solids therein.

2. One of your friends stands on top of “Round Top” and claims that this hill has a very special name given to it because one side is more rounded while the other side is more pointed.

a) What type of hill is “Round Top”? ***A drumlin.***

Your friend standing on “Round Top” claims that he/she is at a higher elevation than anywhere else on this topographic map and challenges you to find another spot that is higher in elevation.

b) Will you win the challenge? Explain. ***Yes, there are higher elevations on the map, east of Meadville the topography rises as it leaves the map edge. One hill by Limber Road is labeled with a 1563 ft. elevation.***

Your friend standing on “Round Top” then claims that he is standing on the steepest hill on the topographic map.

c) Would you agree? How did you use the topographic map to determine this?

You might want to agree. If contour lines are very close together, that indicates a quick rise over a short distance (steepness). Round Top is definitely the steepest hill on the map.

3. a.) Where is the lowest point in elevation on this topographic map quad?
 (Hint: Where does all the water on this map drain to eventually?).
Where French Creek goes off of the edge of the map. There is a bench mark (BM) at this point that is slightly cut off but students should be able to guess that it says 1080 ft.
 Start at this point, travel west uphill.
- b.) Is this hill wooded or cleared? **Wooded.**
 Continue traveling west until you reach a major telephone line. Follow the telephone line downhill.
- c.) What direction are you traveling now? **Northwest**
 Follow this telephone line until it crosses the first light duty road.
- d.) What is the elevation of this road under the telephone line (call this Point A)?
1565 ft.
- e.) From this Point A, how many miles away is the nearest wetland?
0.42 miles (1.1 inches)
- f.) From this Point A, how many miles away in a straight line is the Crawford County Courthouse in Diamond Park? **2.46 miles (6.5 inches)**
4. Put your canoe into French Creek where a light duty road crosses the Creek just south of Saegertown and north of the State Public Access Area. Canoe one mile downstream.
- a.) What is the length from headwaters to mouth of the small, intermittent stream that enters French Creek at this point? **1.349 inches = 0.511 miles**
- b.) How many total vertical feet does this stream drop from headwaters to mouth?
Slightly more than 90 feet.
- c.) On average, how many vertical feet does this stream drop per unit horizontal distance, i.e. what is the average stream gradient?
176 feet per mile.
- d.) Is the stream gradient in c.) above steeper or more gradual than the stream gradient of the next small intermittent stream downstream? **The stream gradient in question c.) is more gradual than the stream gradient of the next small intermittent stream downstream (290 feet per mile stream gradient).**
- e.) What is the watershed area of the stream in question a.)? **0.31 mile²**
 (See the overhead “Key” at the end of this activity for the watershed delineation.)
Graph paper method: 0.31 mile² (Using Creek Connections “reproducible graph paper,” the boundaries of the watershed contain 62 squares. One square mile contains 201.64 squares.)
Mass method: 0.31 mile²
Planimeter method: 0.32 mile²

Townville Quad (Use laminated full quads.)

5. Start at the flagpole at the “High School” building in Townville.
- d.) What is the elevation at this point? **1510 ft.**
 Follow the path of runoff from the flagpole down the hillside to where it drains into a waterway. Let’s call this Point B.
- e.) What is the name of this waterway? **Muddy Creek**
- f.) What is the approximate elevation of this waterway at Point B? **1410 ft.**
- d.) What is the elevation difference between the flagpole at the “High School” and this waterway at Point B? **100 ft.**
- e.) What is the stream order of this waterway at Point B? (Note: consider intermittent as well as perennial tributaries for this exercise.) **3rd order. (See the additional Answer Key pages at the end of this activity for the stream order answer key.)**

6. Start at BM 1212 near the intersection of Dewey and Three Bridges Road. Hike upstream along the small intermittent stream that has no tributaries until you reach the headwaters.

a.) What is the elevation of the headwaters? ***Between 1360 and 1370 feet.***

b.) What is unique about the headwaters of this stream? ***The headwaters are a small pool or pond.***

Now continue hiking directly west until you arrive at the second 1450 feet contour interval line. Trace the flow of runoff from this point all the way until it flows into a stream.

c.) Follow this stream downstream and write down the various land uses that the stream flows through. ***Forest, agricultural land (you can tell the white cleared land is farmland because of barn symbols), roadway (Rt. 77), and small town (Little Cooley).***

d.) Determine the stream order for this small creek at its mouth. Consider intermittent and perennial tributaries for this exercise. ***3rd order. (See the additional Answer Key pages at the end of this activity for the stream order answer key.)***

e.) What is the name of the waterway that this small stream empties into? ***Muddy Creek.***

7. Woodcock Creek is one of the main streams on this topographic map quad.

a.) If you were unfamiliar with this waterway and area, how could tell on the topographic map whether Woodcock Creek flows NORTH or SOUTH through the Erie National Wildlife Refuge?

Water flows downhill, from higher elevations to lower elevations. Woodcock Creek crosses many contour lines that indicate elevation. One of the contour lines it crosses just north of the Erie National Wildlife Refuge has an elevation of 1320 ft. Just south of the word "Creek," Woodcock Creek crosses another contour line that has an elevation of 1310 ft. A bit farther north, the creek crosses the 1300 ft. index contour line. In order for Woodcock Creek to flow downhill, it must flow north from the Erie National Wildlife Refuge towards Lyona.

In addition to Woodcock Creek, Muddy Creek is another large creek on this topographic map. You might have learned that large creeks often have large watersheds. The Woodcock Creek and the Muddy Creek watersheds border each other. Find the section of the topographic map shown to the right on your topographic map (near the Erie National Wildlife Refuge). Start on the mark shown to the right, travel along the light duty road northeast (as indicated by the arrow direction). Continue to travel this road, and find the exact place along this road that is the watershed boundary between the Muddy Creek and Woodcock Creek Watersheds.

b.) Describe its location in detail here:

See * on map at right.

The boundary between the Muddy Creek and the Woodcock Creek watersheds is at an elevation of approximately 1628 ft. just northwest of the hilltop labeled 1661 ft.

c.) What kind of land use exists at this location?

The land at this site is cleared and there are several fence lines and a barn in the surrounding area. Therefore, it is probably agricultural land.

