How to Read Topography Maps and Delineate Watershed Boundaries

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Nonpoint Education for Municipal Officials

RI NEMO provides training and technical tools to help local decision makers manage impacts of changing land use on water resources.

RI NEMO is part of the URI Cooperative Extension Water Quality Program and a member of the National NEMO network.

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Acknowledgments

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and

URI College of the Environment and Life Sciences (CELS), Cooperative Extension.

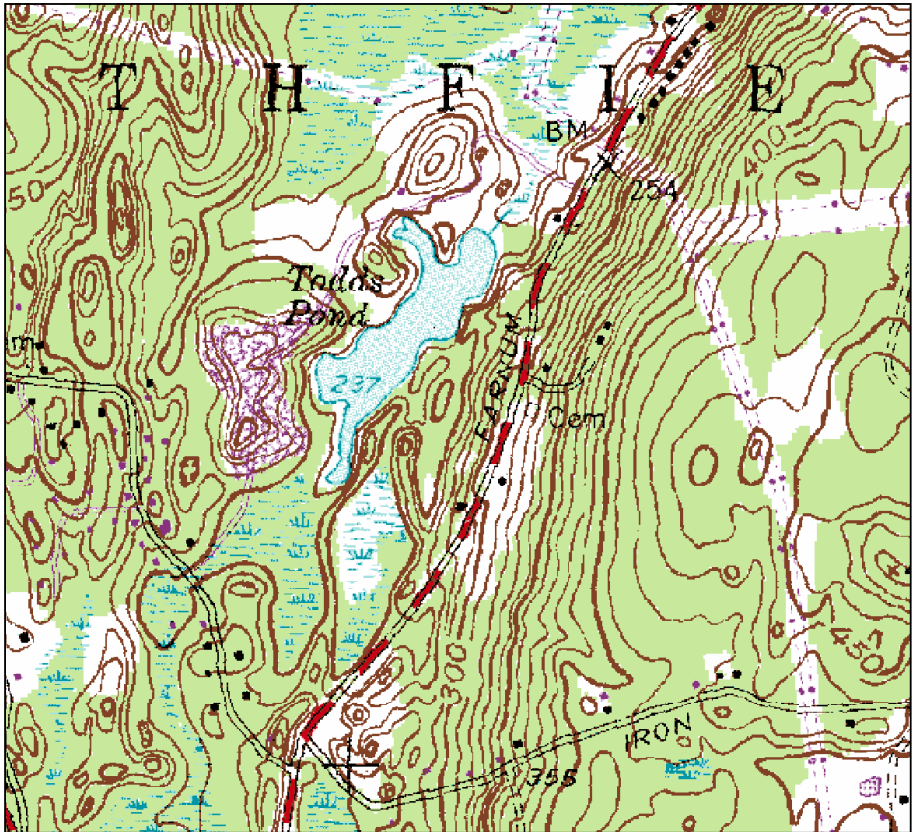
Topics

- **Map Basics**
- **Working with topography maps**
- **Practice exercise**

Map Basics

Key Map Elements

- Title
- North arrow
- Scale
- Legend



Key Map Elements

North Arrow

Scale

Written Scale

Ratio scale

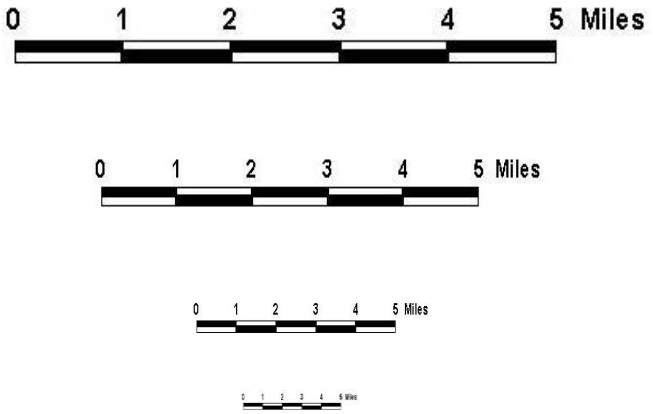
1:24,000

1 inch = 24,000 inches

Equivalent scale

1” = 2000 ft.

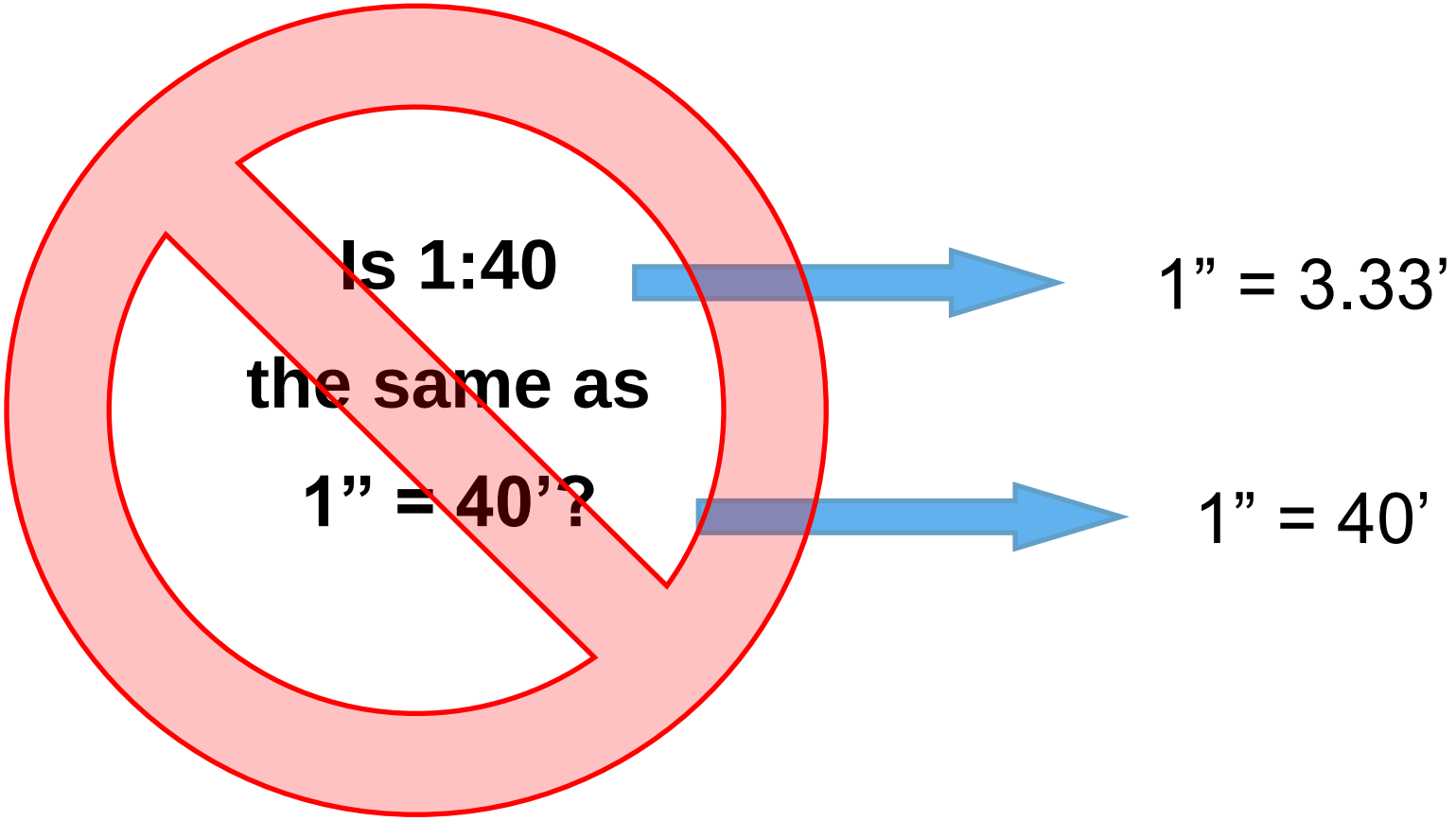
Graphical (Bar) Scale



Graphic scales are the most reliable!

Beware of Xerox Distortion

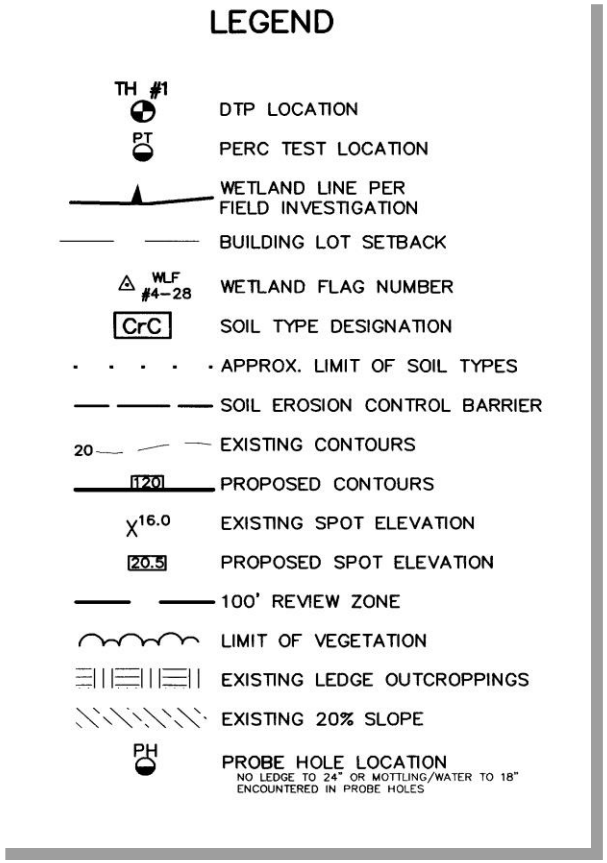
Question: Are Ratio and Equivalent scales different?



Legends

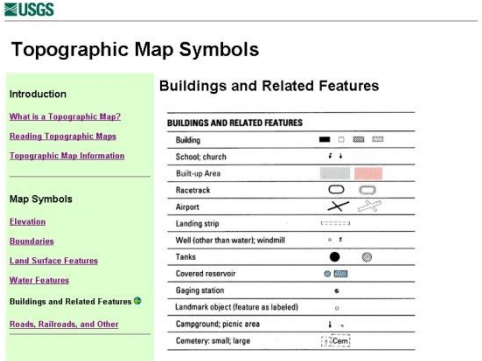
Provide a guide to the symbols used

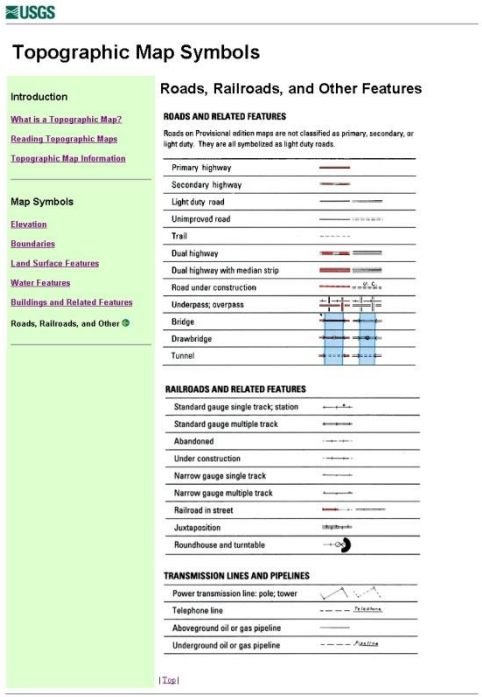
Watershed Basins	Basins
Town	Town
Migratory Fish Runs	Fish Runs
Tidal Wetlands	Tidal Wetlands
Eelgrass	Eelgrass
Water Features	Streams, Lakes, Water, Shore
Urban Growth	Developed before 1985 Turf and Grass before 1985 Water Undeveloped Developed 1985-1990 Turf and Grass 1985-1990 Developed 1990-1995 Turf and Grass 1990-1995 Developed 1995-2002 Turf and Grass 1995-2002



USGS

Topographic Map Symbols





http://erg.usgs.gov/isb/pubs/booklets/symbols

USGS

Topographic Map Symbols

Use of Color

Blue – used for all water features.

Red – major roads & highways.

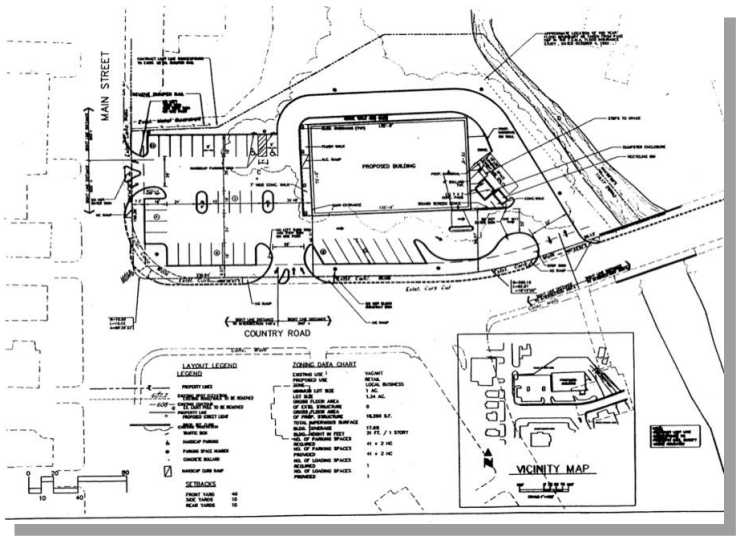
Green – identifies vegetation such as forest cover, orchards, etc.

Brown – used to depict contour lines as well as some landform features.

Black – man-made features & all labeling & lettering.

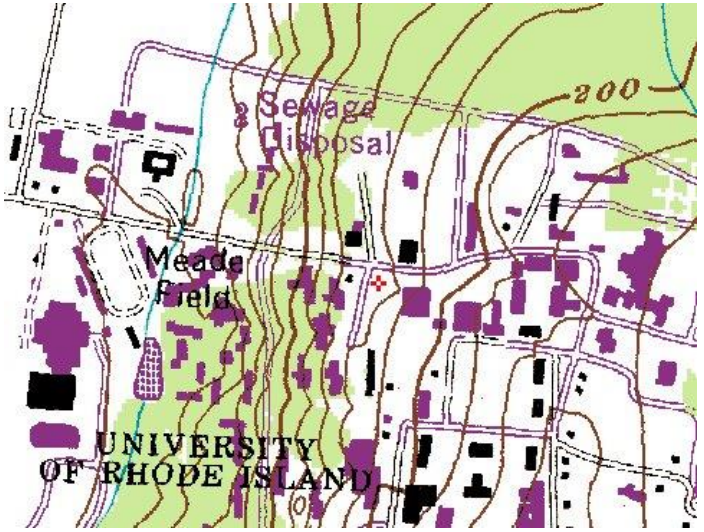
Purple – revisions & new map data.

Large or Small Scale?



1 : 480

1” = 40 ft.



1 : 24,000

1” = 2,000 ft.

Large Scale

High detail

Small Area

Map features are large

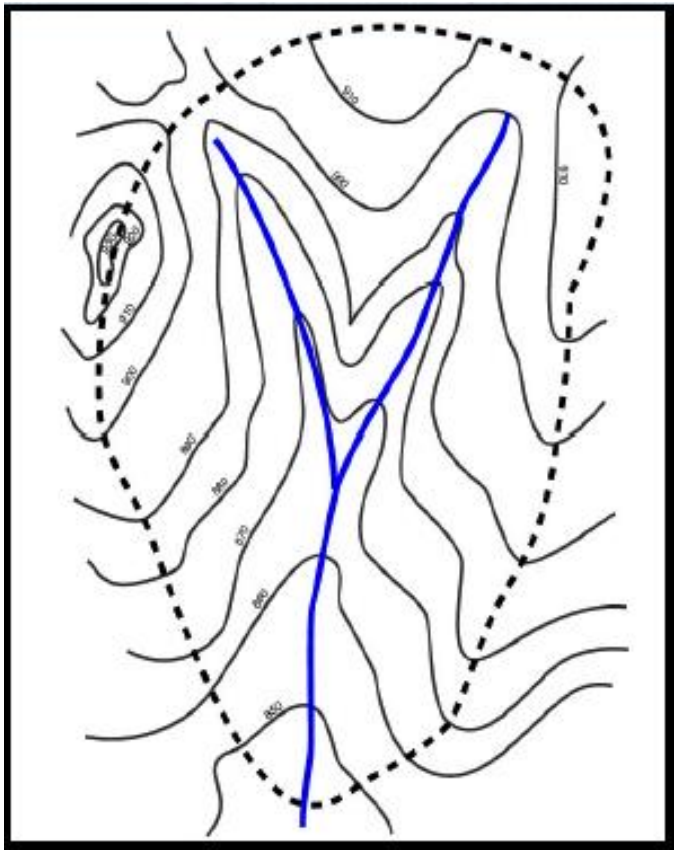
Small Scale

Low detail

Large Area

Map features are small

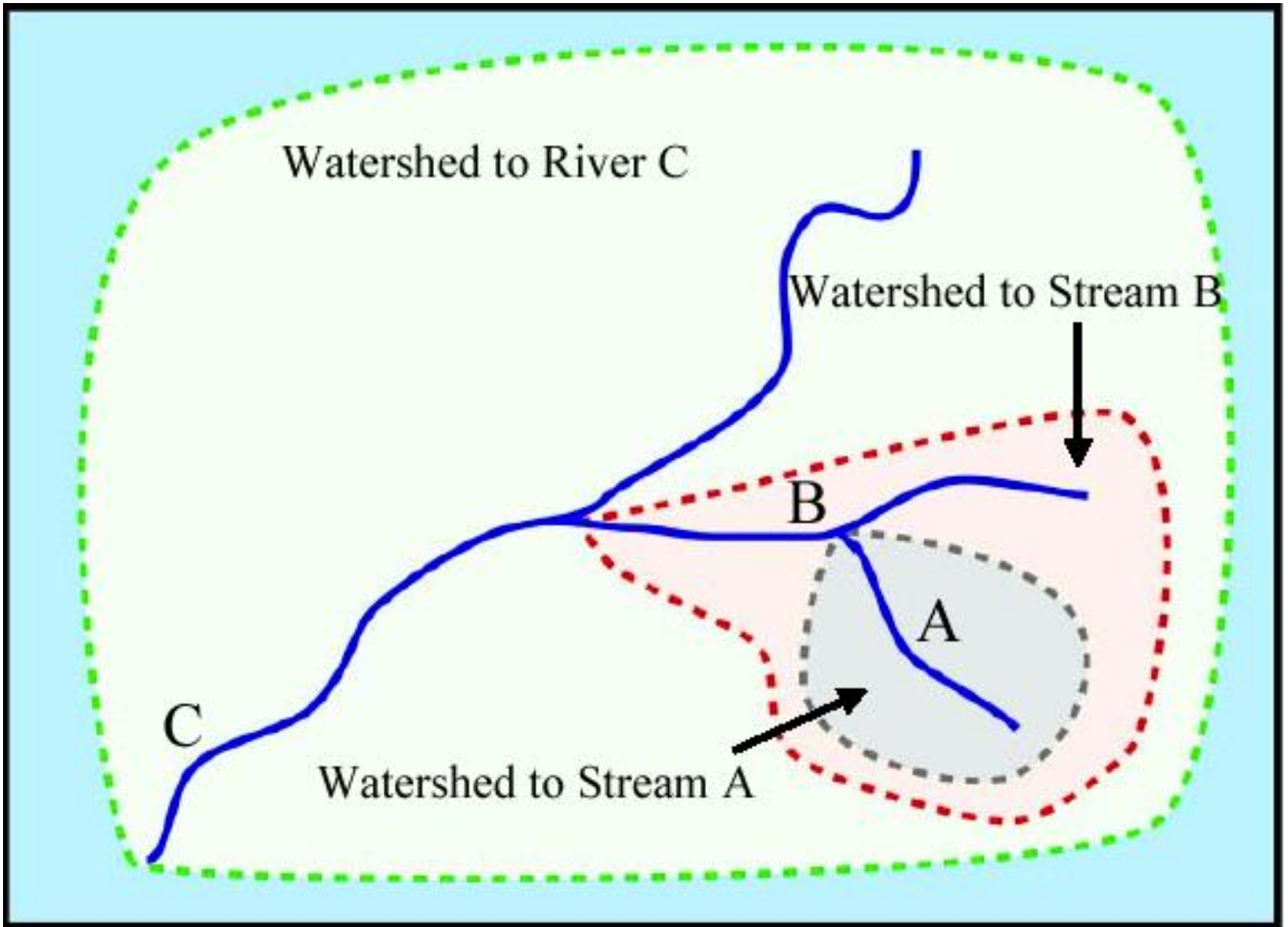
What is a Watershed ?

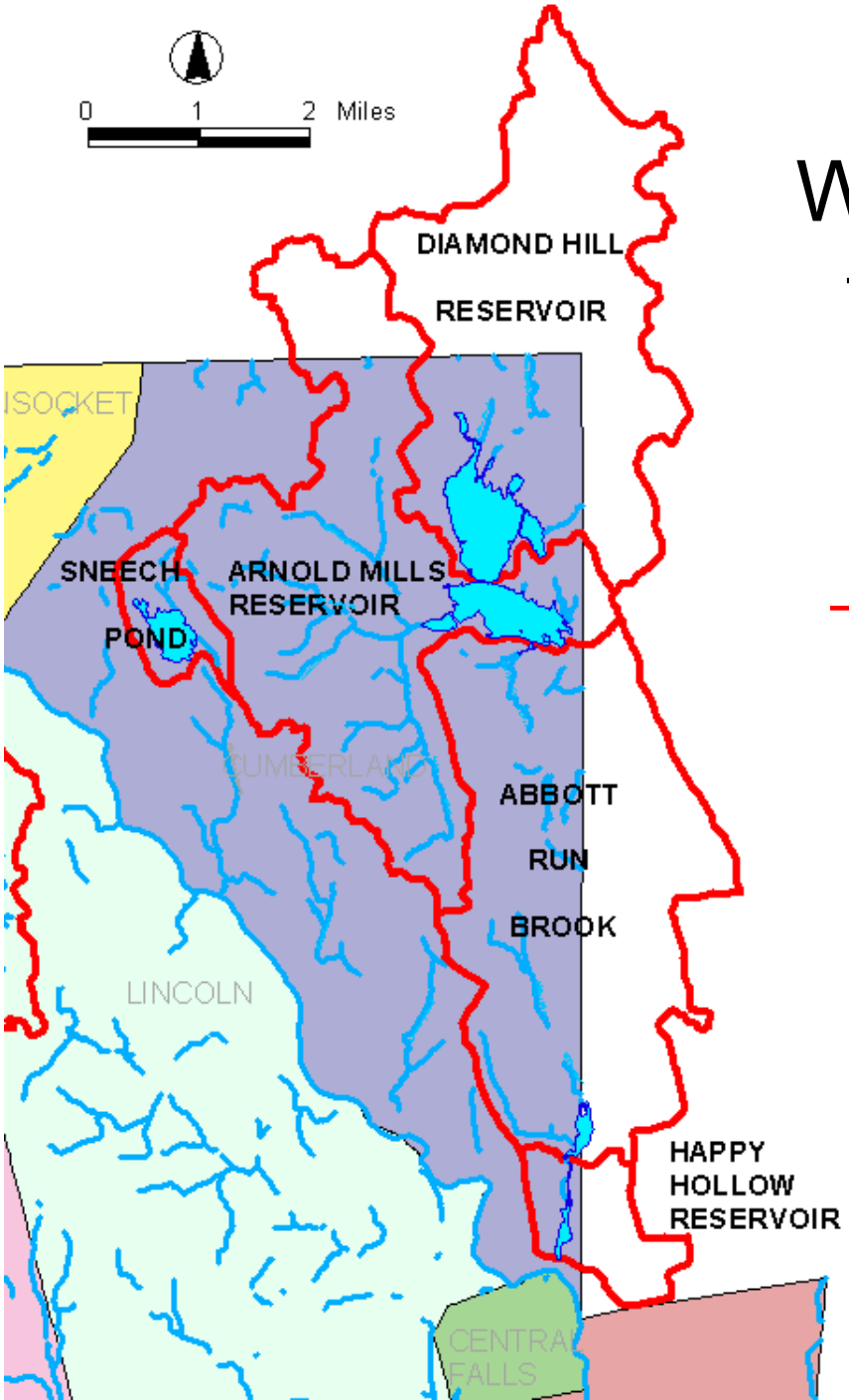


The area of land that drains to a common outlet - such as a lake, stream segment or bay.

Watershed boundaries are based on topography.

All land is in one watershed or another





Watersheds don't follow town or state borders

The watershed boundaries of the Pawtucket water supply reservoirs

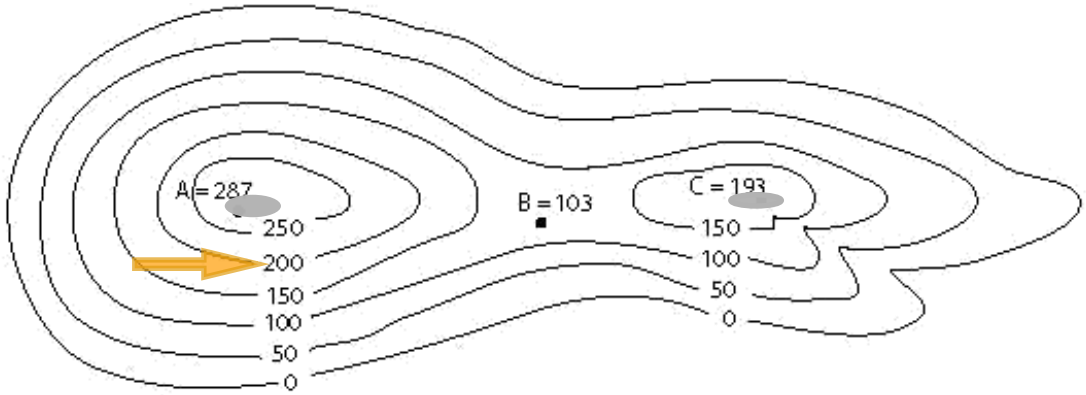
Town of Cumberland

Working with Topography Maps

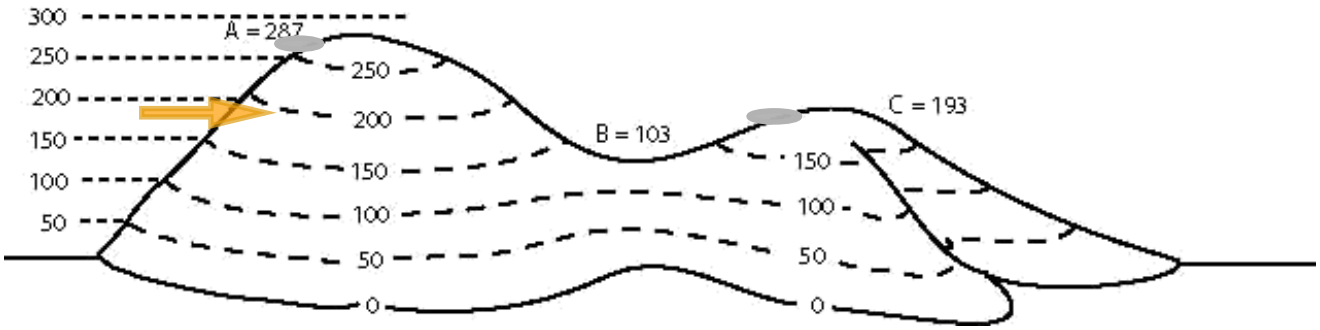
Topography

Contours: an imaginary line that connects points of equal elevation

Plan View

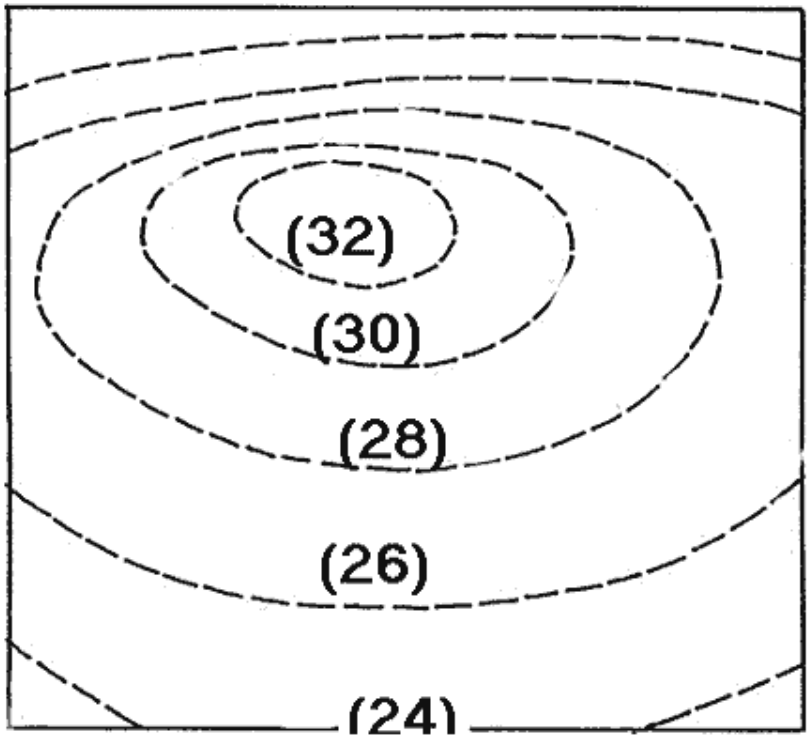


Terrain relief



Topography

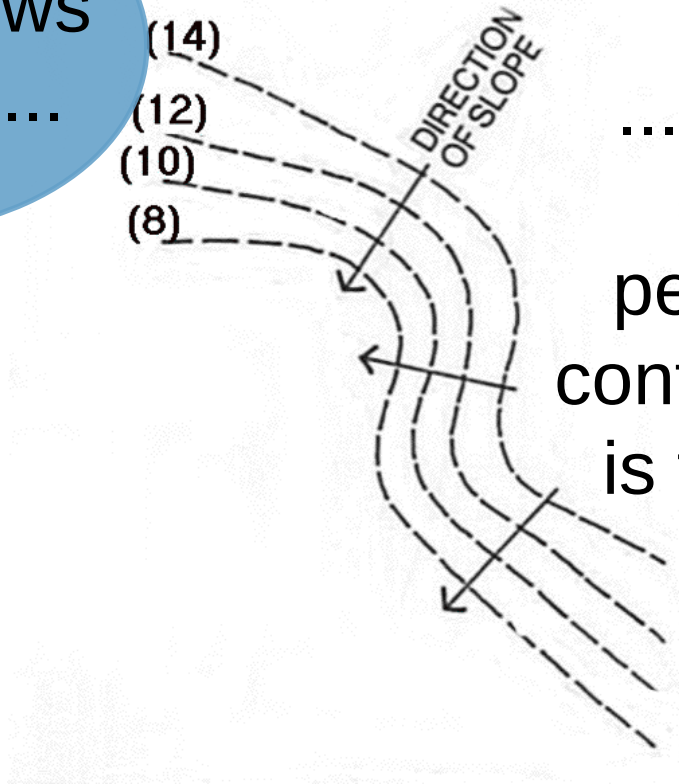
Contours always connect, but not always within the map boundaries...



Topography

Slope direction is calculated perpendicular to the contour lines.

Water flows downhill...



...so the direction of flow is always perpendicular to the contour lines, since this is the steepest slope

How to read a topo map...

- The **contour interval** is the vertical distance between contours, generally 10ft. on topo maps. **Contour lines** never cross each other.

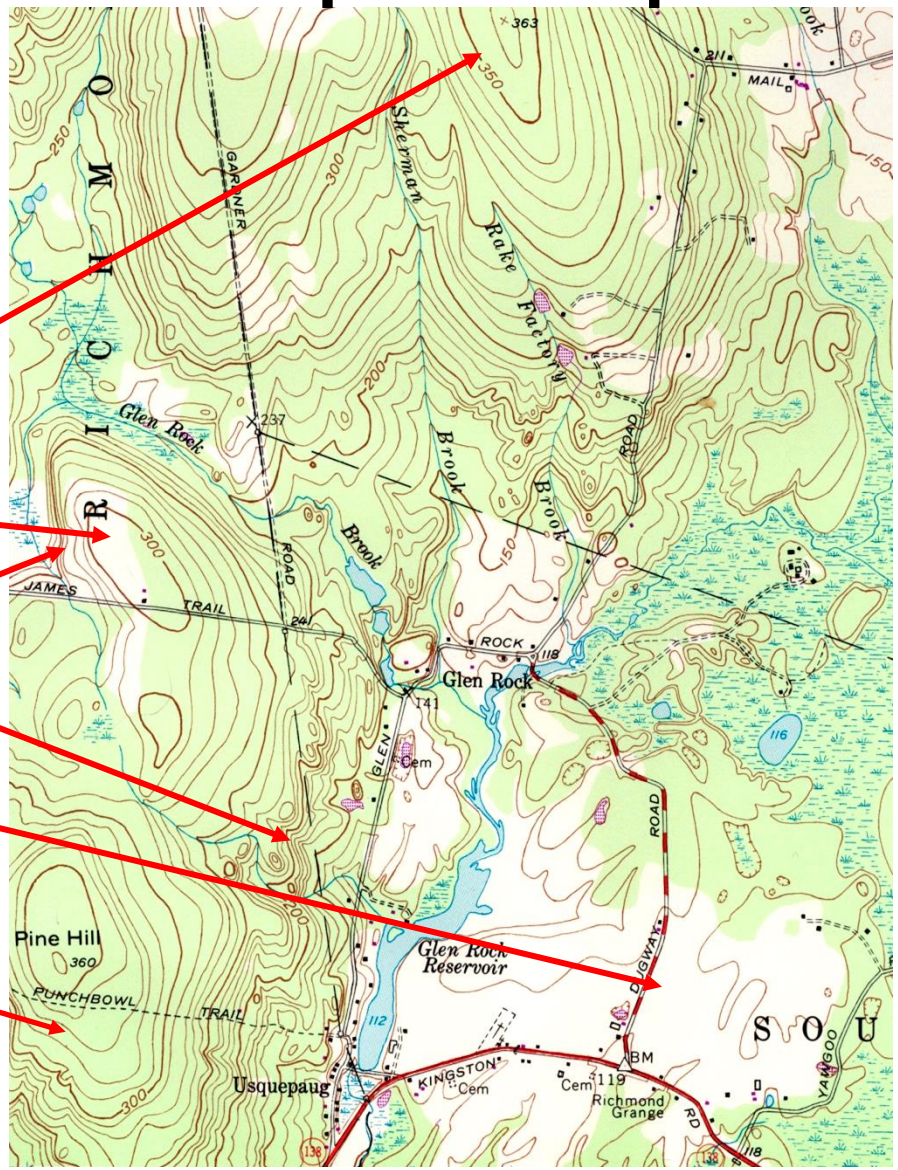
- Every fifth contour line is an **index contour** and is usually labeled.

- **Hilltops** are indicated by progressively smaller, closed contours.

- Contours close together indicate a **steep slope**.

- Contours far apart indicate a **gentle slope**.

- **Forest Cover** is green



How to read a topo map...

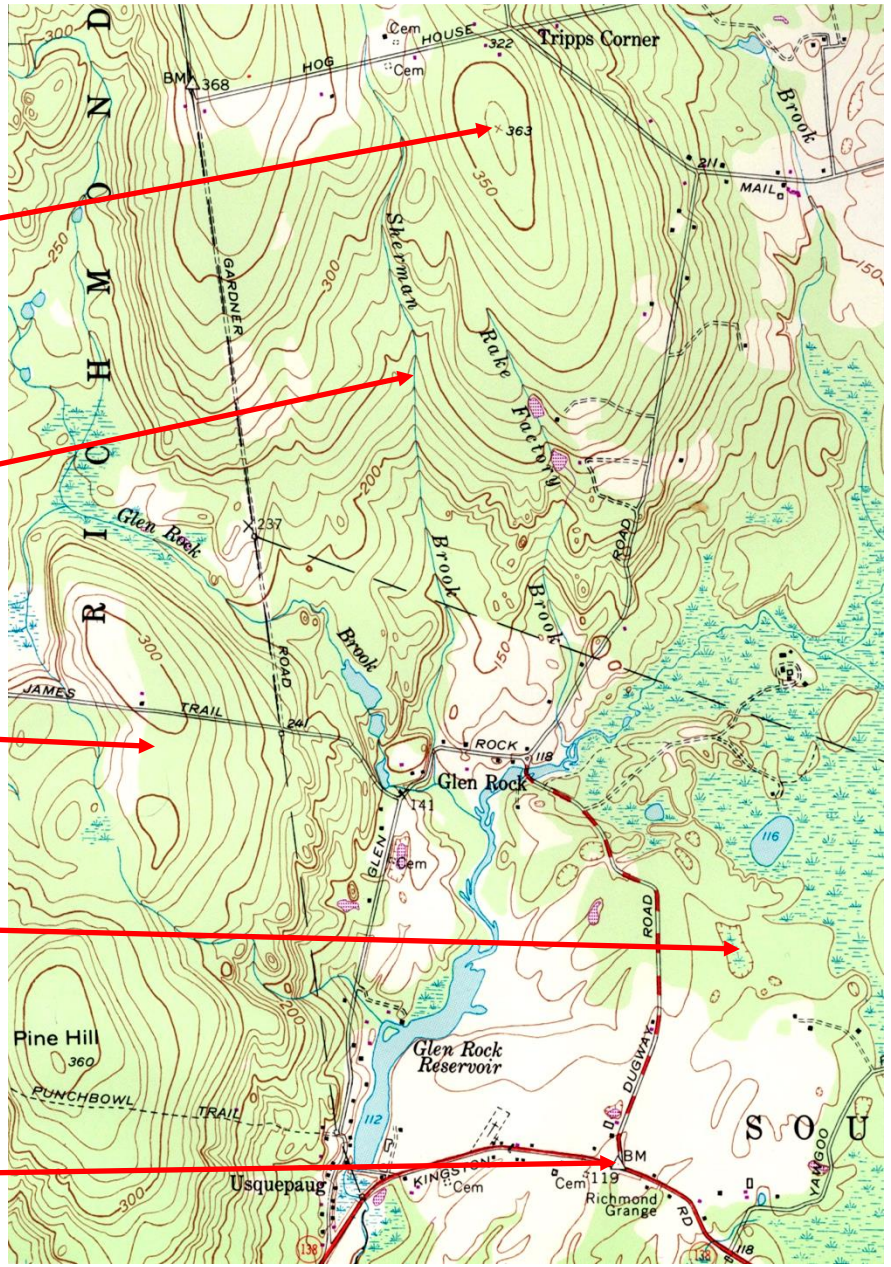
- A **spot elevation** is a point with a known elevation.

- When contour lines cross a stream, they form a "**V**" that always points **uphill**.

- A **saddle** is a lower area, often on a ridge, between two areas of higher elevation.

- **Depressions** are indicated by closed contours with inward-pointing ticks.

- A **benchmark (BM)** is a point of known position & elevation used as a point of reference for surveys



Review of Topo Map Basics

- **Contour lines** never cross each other.
- USGS 1:24,000 topos typically use 10’ contour intervals.
- Every fifth contour line is an **index contour** (dk brown) and is usually labeled
- Contours close together indicate a **steep slope**.
- Contours far apart indicate a **gentle slope**.
- **Hilltops** are indicated by progressively smaller, closed contours.
- **Depressions** are indicated by closed contours with inward-pointing ticks.
- A **spot elevation** is a point with a known elevation.
- A **saddle** is an area, often on a ridge, between two areas of higher elevation. There is high ground in two opposite directions and lower ground in the other two directions.
- When contour lines cross a stream, they form a “**V**” that always points **uphill.**
- As a general rule, **water flows** downhill **perpendicular** to contour lines.

Concepts for delineating watershed boundaries.

• A watershed is a land area draining to a common outlet.

• All land is in a watershed.

• Watershed boundaries can be drawn to show smaller parts of larger watersheds. The terms basin, watershed, subwatershed, drainage area, hydrologic unit, catchment, subcatchment, are used interchangeably to describe a watershed. There are no size rules but in general, the terms “basin” and “watershed” are used to describe larger drainage areas.

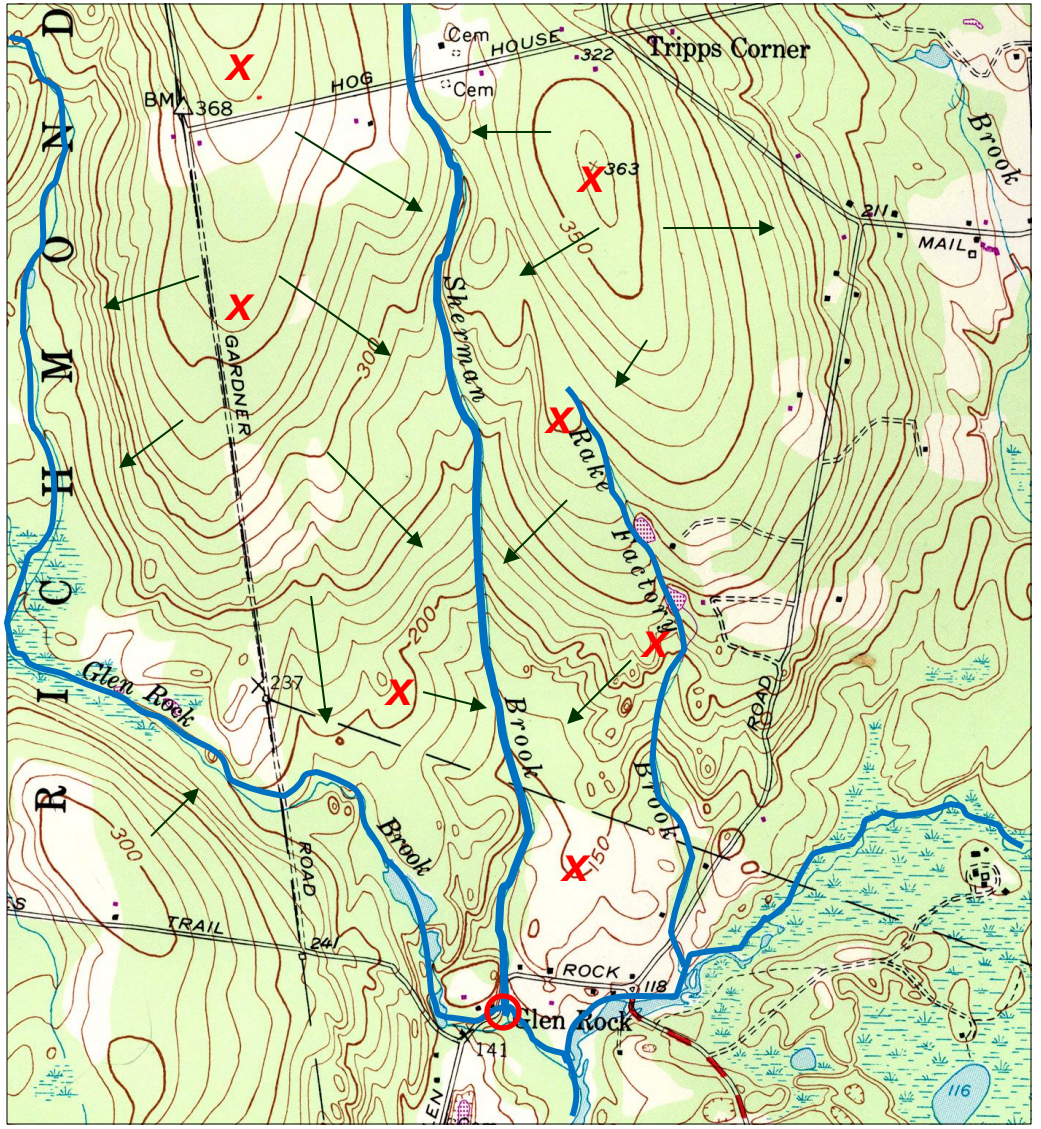
• Watersheds can be drawn for any area. The point chosen as the watershed outlet determines the boundaries.. For example, the mouth of the Pawtuxet River as it flows into Narragansett Bay is the outlet for the entire Pawtuxet River watershed, including the Scituate Reservoir and its watershed. At a project scale, a developer must identify the point(s) where a stream or wetland leaves the property, then identify areas that drain to that outlet, either on or upgradient of the property.

• Natural drainage patterns may be altered by man made features. For example, roads are often built to follow ridges and other high points, so drainage divides often follow roads. Stormwater drainage systems may redirect water flow away from naturally occuring patterns. In urban areas, field checking is needed to verify water flow direction based on locations of stormdrain inlets and outlets.

Watershed Delineation Example

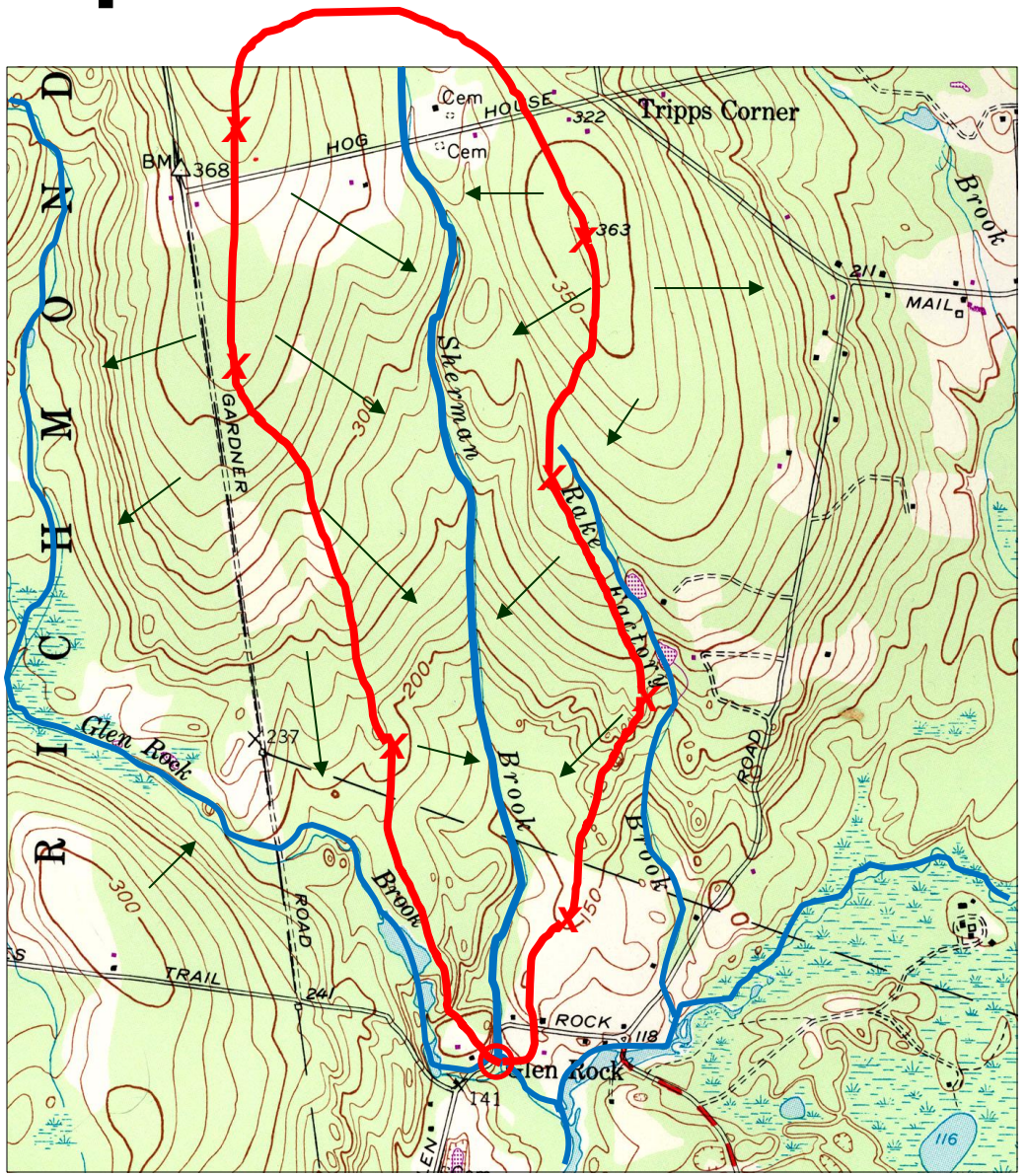
Sherman Brook Watershed

1. ***Identify the watershed outlet. Mark with ○.***
2. ***Highlight Sherman Brook & other nearby watercourses and flow direction.***
3. ***Look for ridge lines & saddles. Mark high points with X.***
4. ***Visualize surface flow direction from high points. Draw arrows to indicate direction of flow.***
5. ***Trace outline of watershed beginning at outlet, connecting high points. Cross contours at right angles. Form a closed and continuous boundary.***



Delineation Steps

- ***Begin to connect high points, following ridges when present.***
- ***The watershed boundary should cross each contour line at a right angle.***
- ***If you are unsure as to the placement of your delineation, try drawing direction of flow arrows on either side (staying perpendicular to the contour lines). Flow within your boundary should drain into Sherman Brook, while flow outside you boundary should drain elsewhere.***
- ***The boundary should be closed and continuous.***



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Now try it on your own

- *Begin to connect high points, following ridges when present.*
- *The watershed boundary should cross each contour line at a right angle.*
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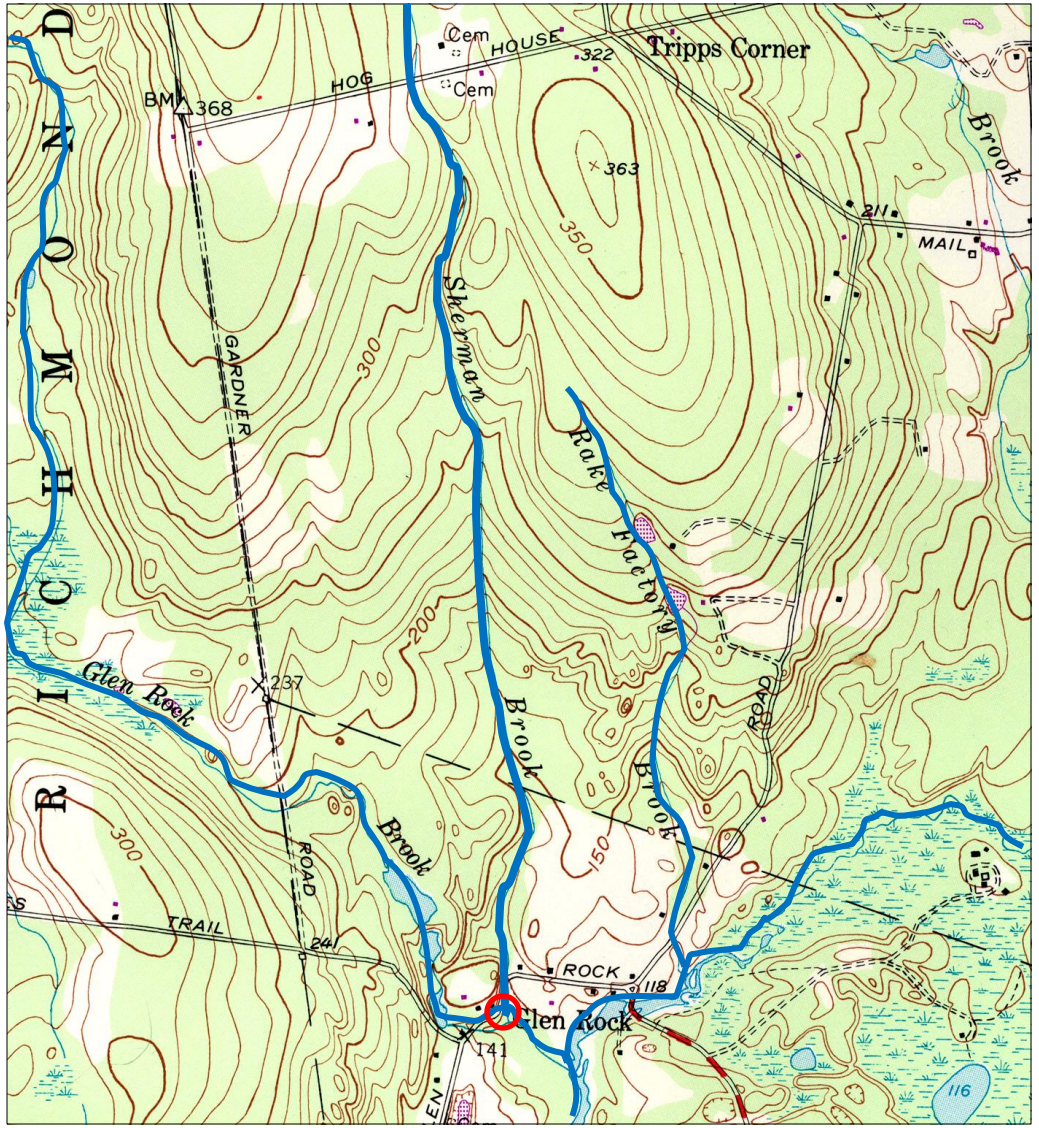

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Your Turn

Watershed Delineation Example

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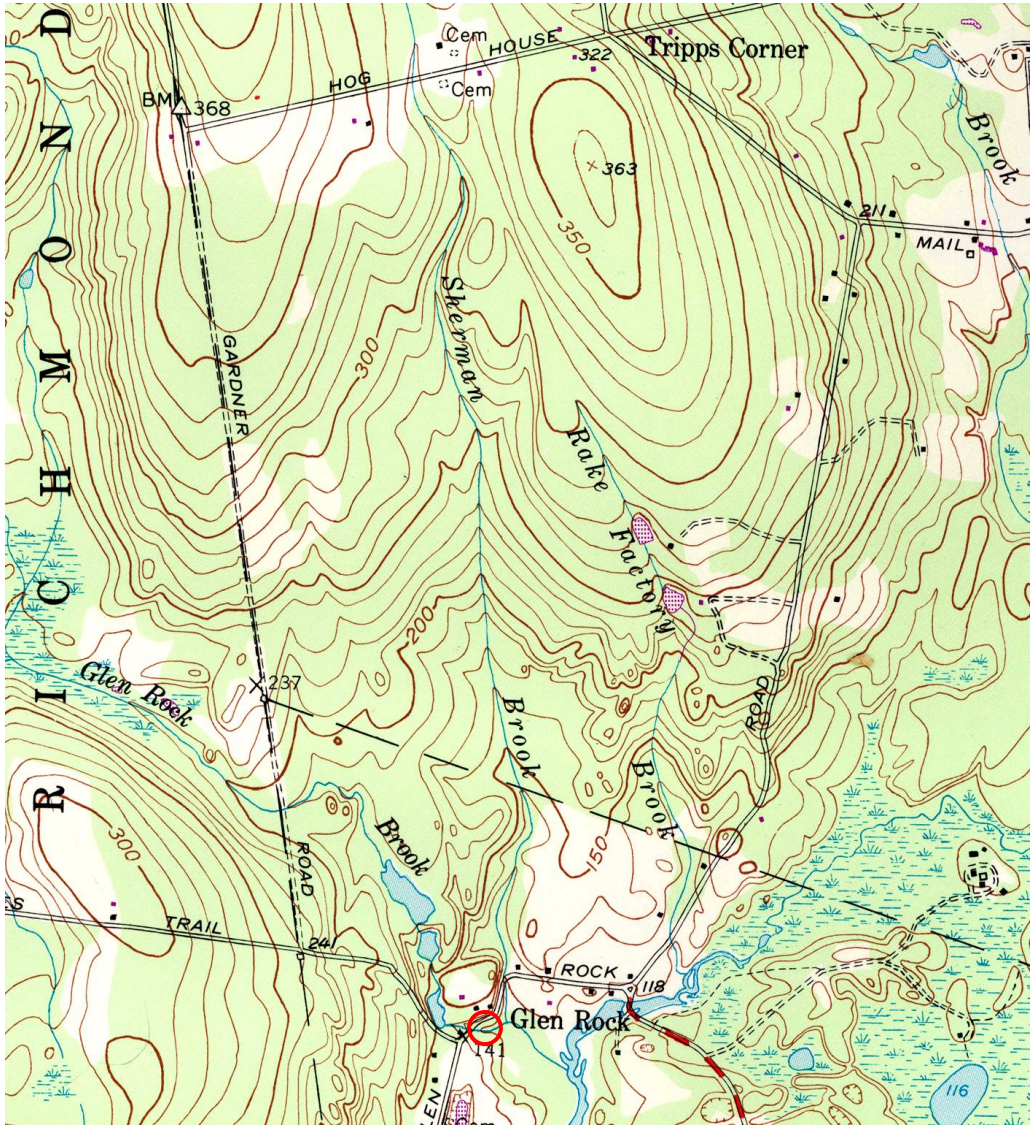

Watershed Delineation Example

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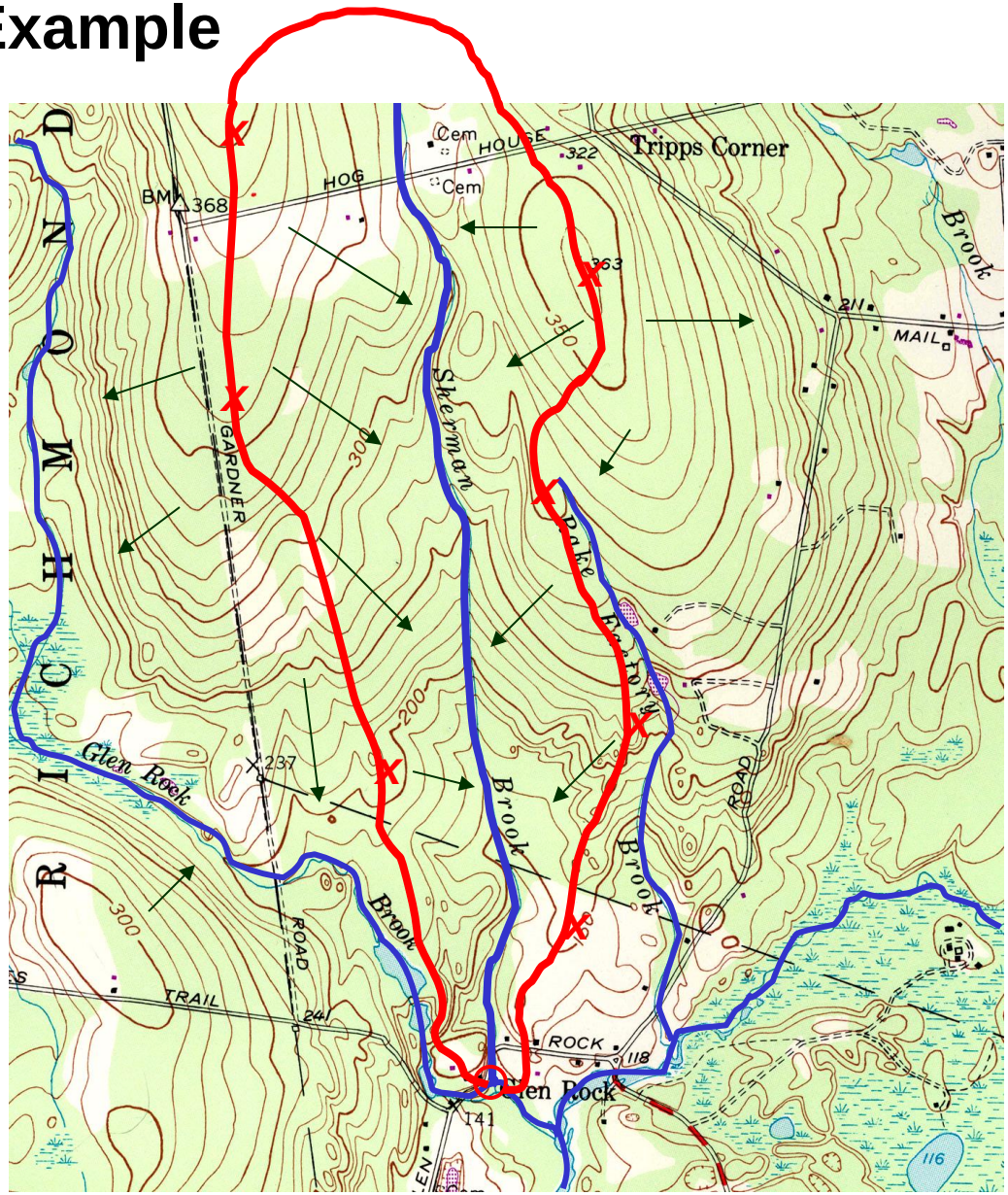
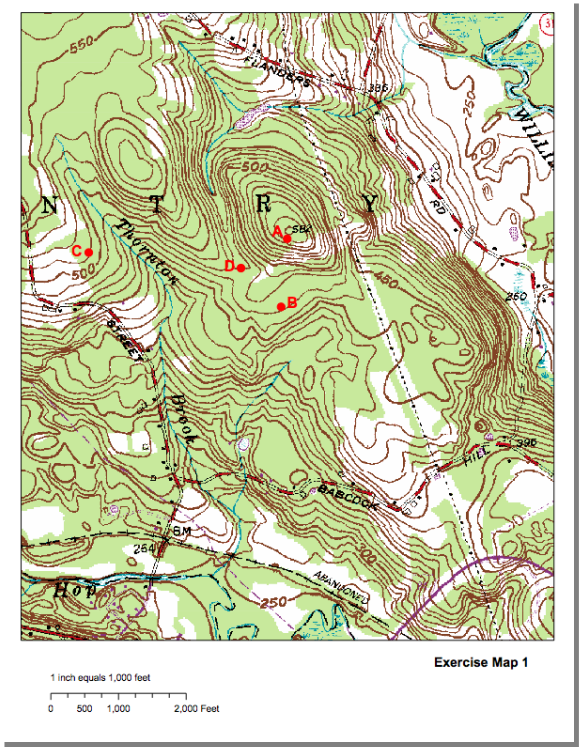


Extra Practice

Topography

Your turn!



Find or calculate the following:

-What's missing?

-highest elevation

-elevation of Pt. A

-the distance between Pts A & B

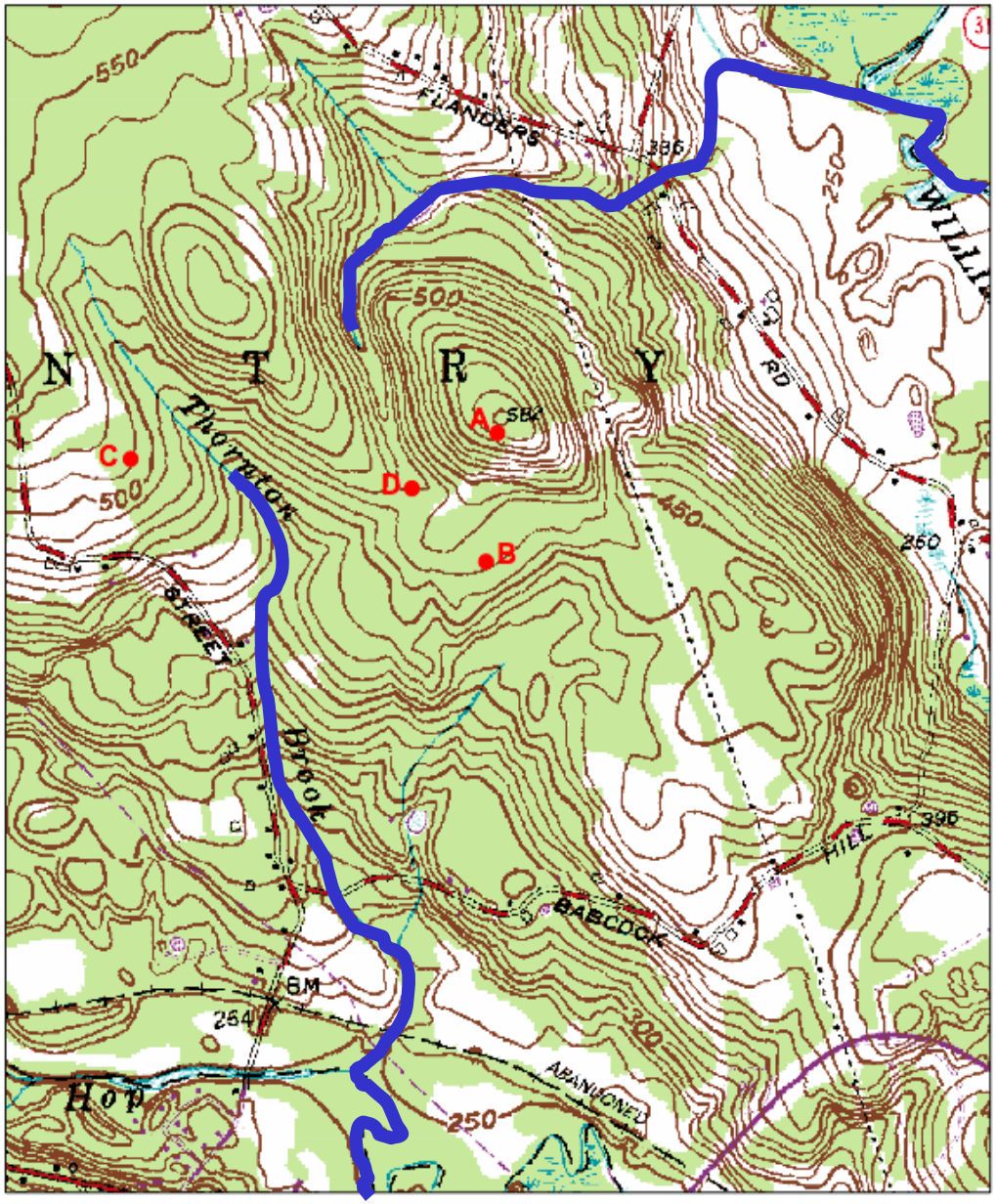
-the change in elevation between A & B

- the percent slope between A & B

-Which is higher C or D?

-Which direction would water flow from C? D?

-Where would that water leave the map edge?



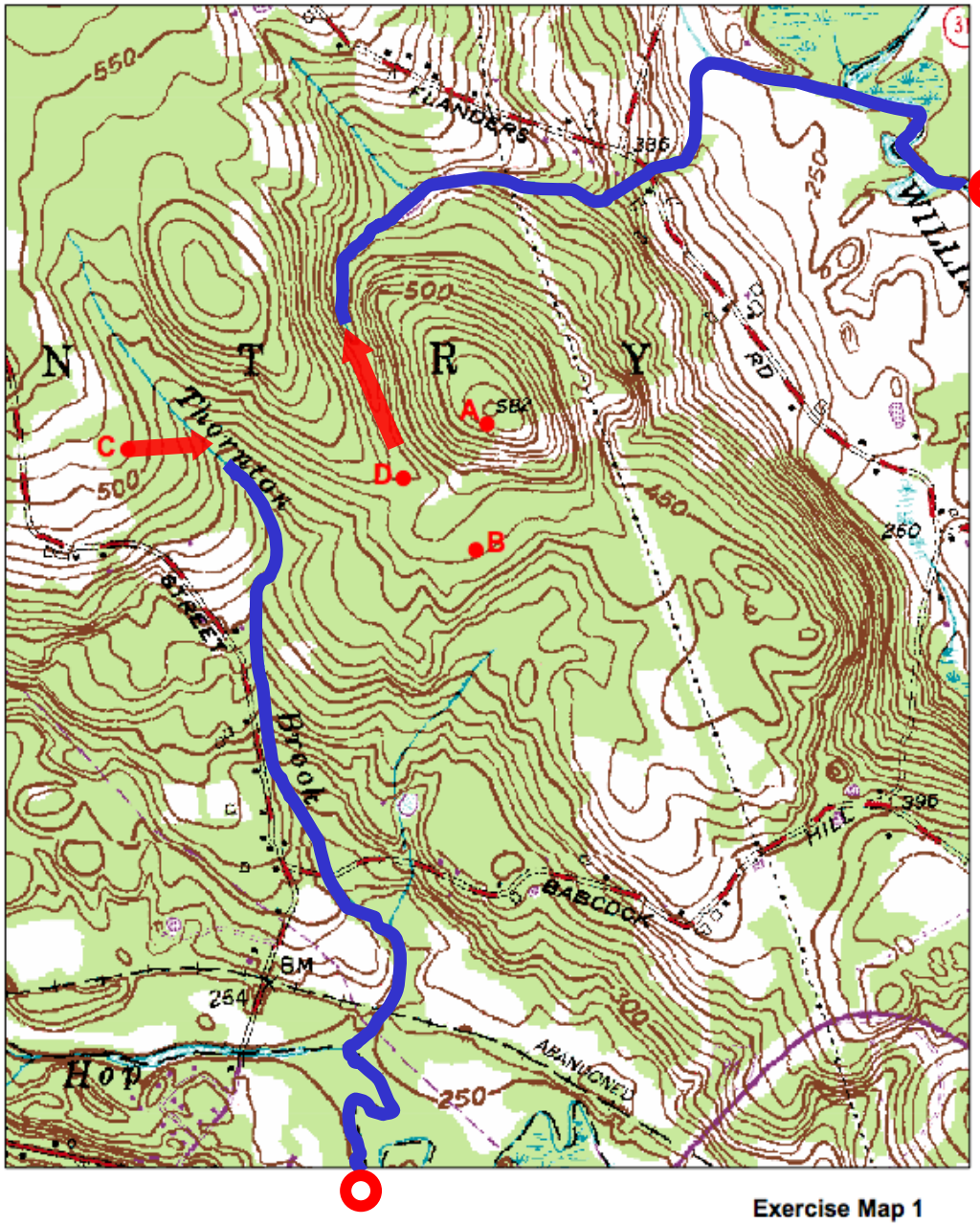
Exercise Map 1

1 inch equals 1,000 feet

0 500 1,000 2,000 Feet

Topography Exercise

1. What's missing?
2. Highest elevation?
3. Elevation of point A?
4. The distance between A & B?
5. The change in elevation between A & B?
6. The percent slope between A & B?
7. Which is higher C or D?
8. Which direction would water flow from C? D?
9. Where would that water leave the map edge?



Exercise Map 1

1 inch equals 1,000 feet

0 500 1,000 2,000 Feet

Topography Exercise Answers

1. -What's missing?

   North Arrow, Legend, Title

2. -highest elevation

   582 ft

3. -elevation of Pt. A

   570 ft

4. -the distance between Pts A & B

   1,000 ft

5. -the change in elevation between A & B

   100 ft

6. - the percent slope between A & B

   10%

7. Which is higher C or D?

   C

8. Which direction would water flow from C? D?

   →

9. Where would that water leave the map edge?

   ○

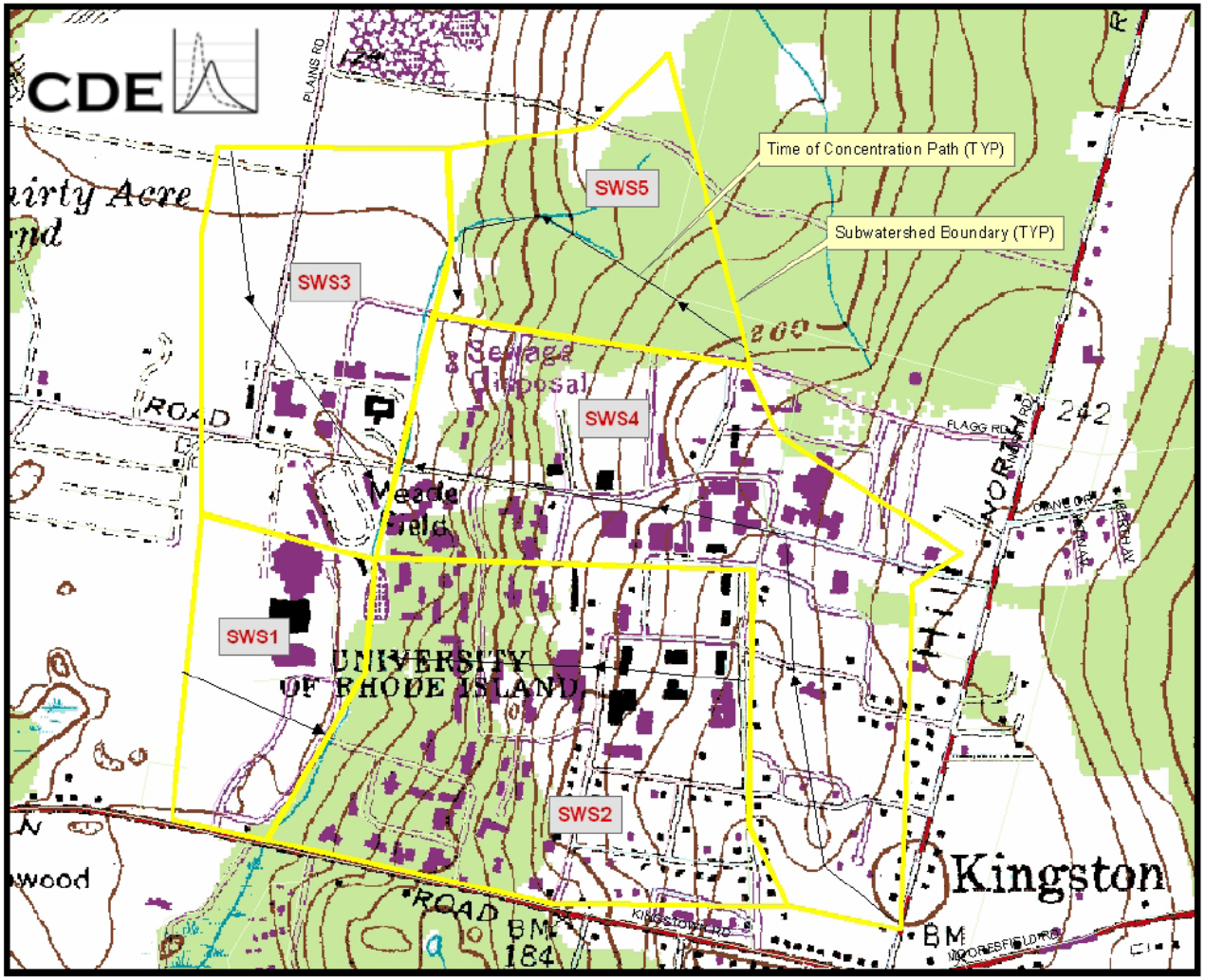


Figure 3 – White Horn Brook Subwatersheds (Source: RIGIS & USGS)

Caution! In areas with urban drainage systems, such as the URI Kingstown campus shown here, drainage boundaries may not follow topography.

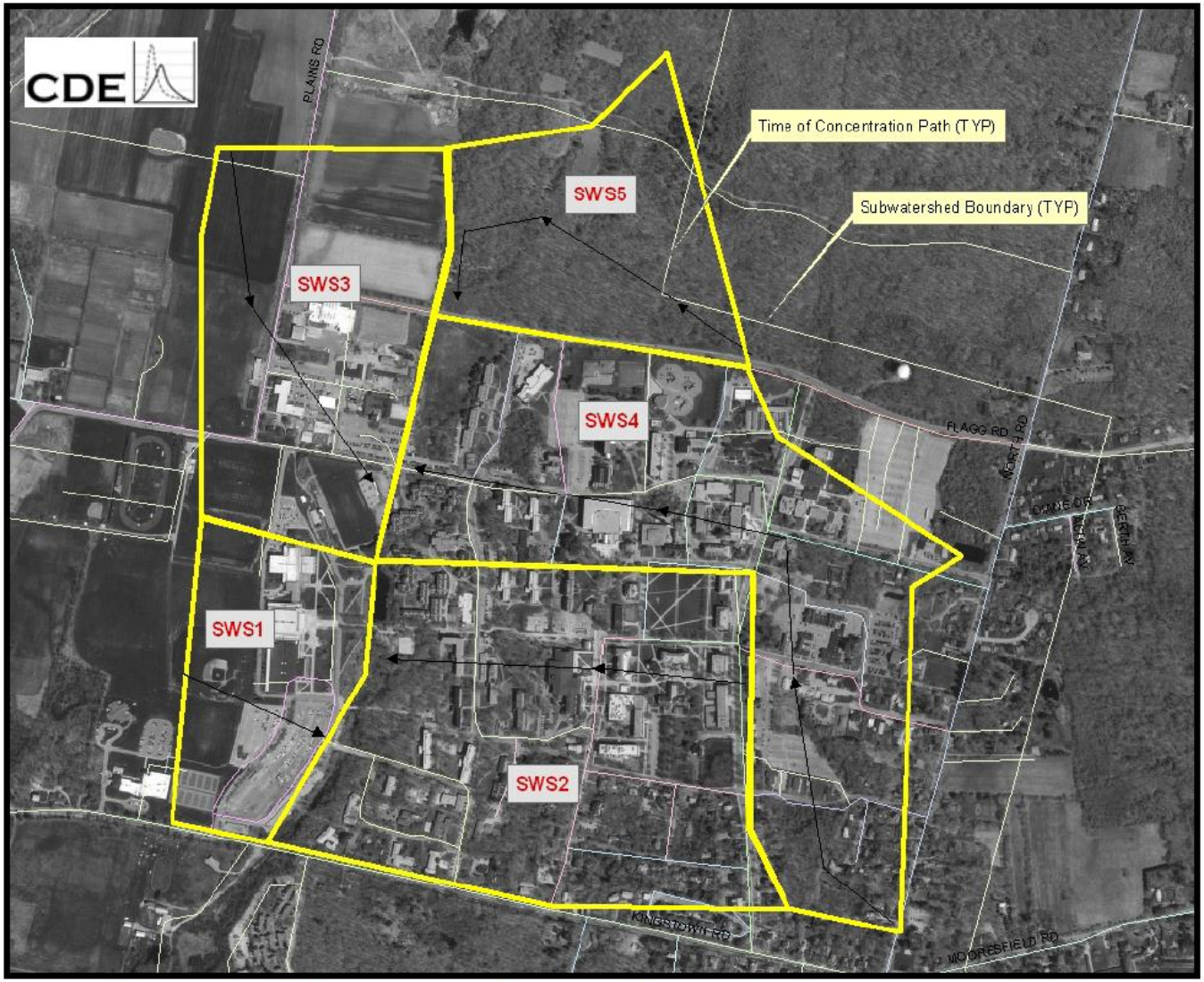


Figure 4 – White Horn Brook Subwatersheds (Source: RIGIS)

This aerial photo clearly shows the urban drainage boundaries in yellow.

Sources

Watershed Delineation Tips: Christopher Mason, Adjunct Professor, URI Natural Resources Science Dept. and President, Mason & Associates, Inc.

Appendix D. Watershed Delineation: Maine Department of Environmental Protection. 2009/2010. Stream Survey Manual Vol 1 and 2, Appendix D. Augusta, Maine. http://www.maine.gov/dep/water/monitoring/rivers_and_streams/vrmp/stream-survey-manual/index.html

RI Community Resource Inventory Maps – links to online topography, watershed, other RI natural resources maps.

Resources: **www.uri.edu/ce/wq**

www.ristormwatersolutions.org

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