CE 5361 SURFACE WATER HYDROLOGY

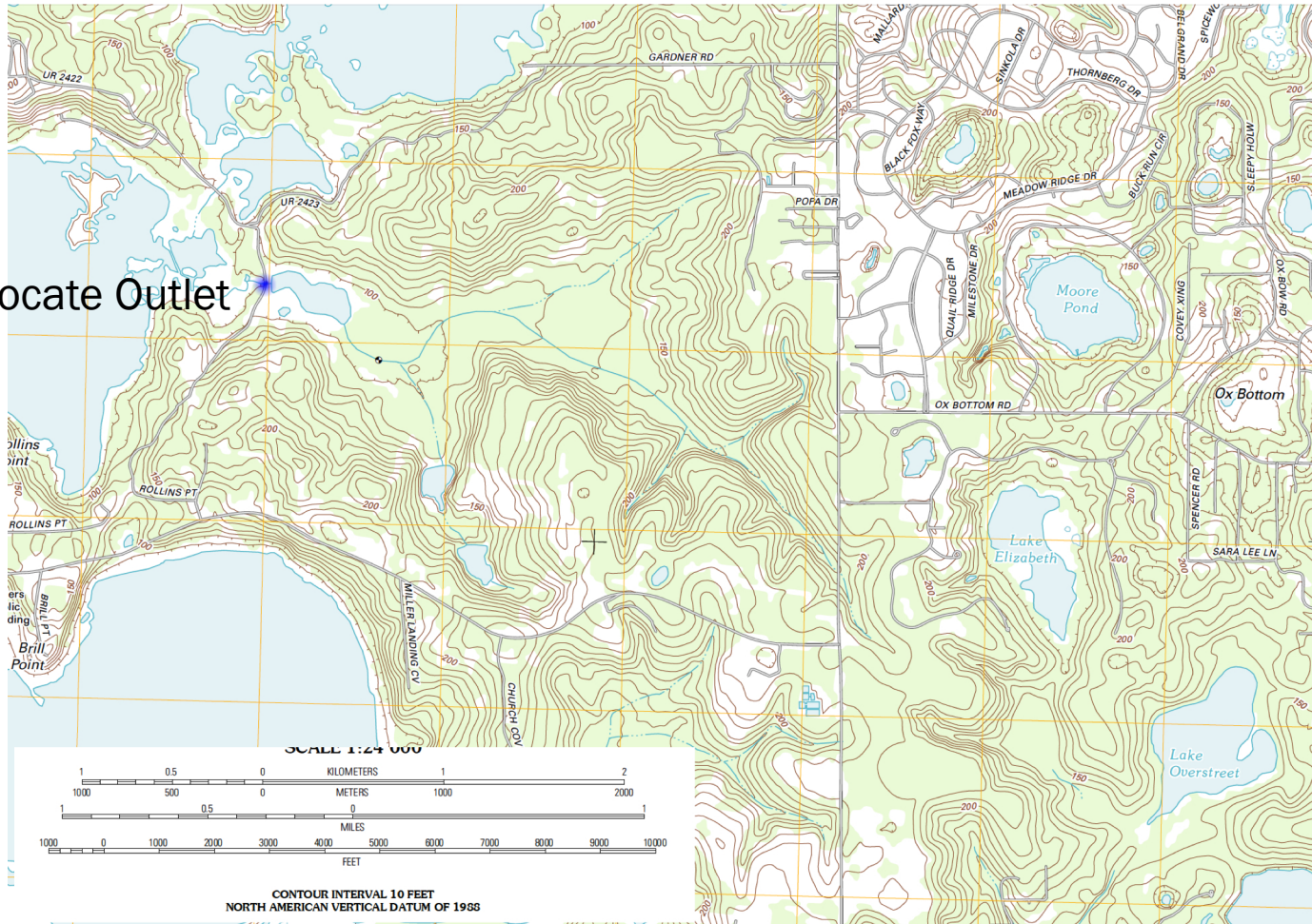## WATERSHEDS; WATERSHED DELINEATION; WATERSHED METRICS

WHAT IS A WATERSHED?

↗ Topographic area that collects and discharges surface streamflow through one outlet or mouth (pour point)

↗ The area on the surface of the Earth that drains to a specific location

↗ In groundwater a similar concept is called a groundwater basin – only the boundaries can move depending on relative rates of recharge and discharge
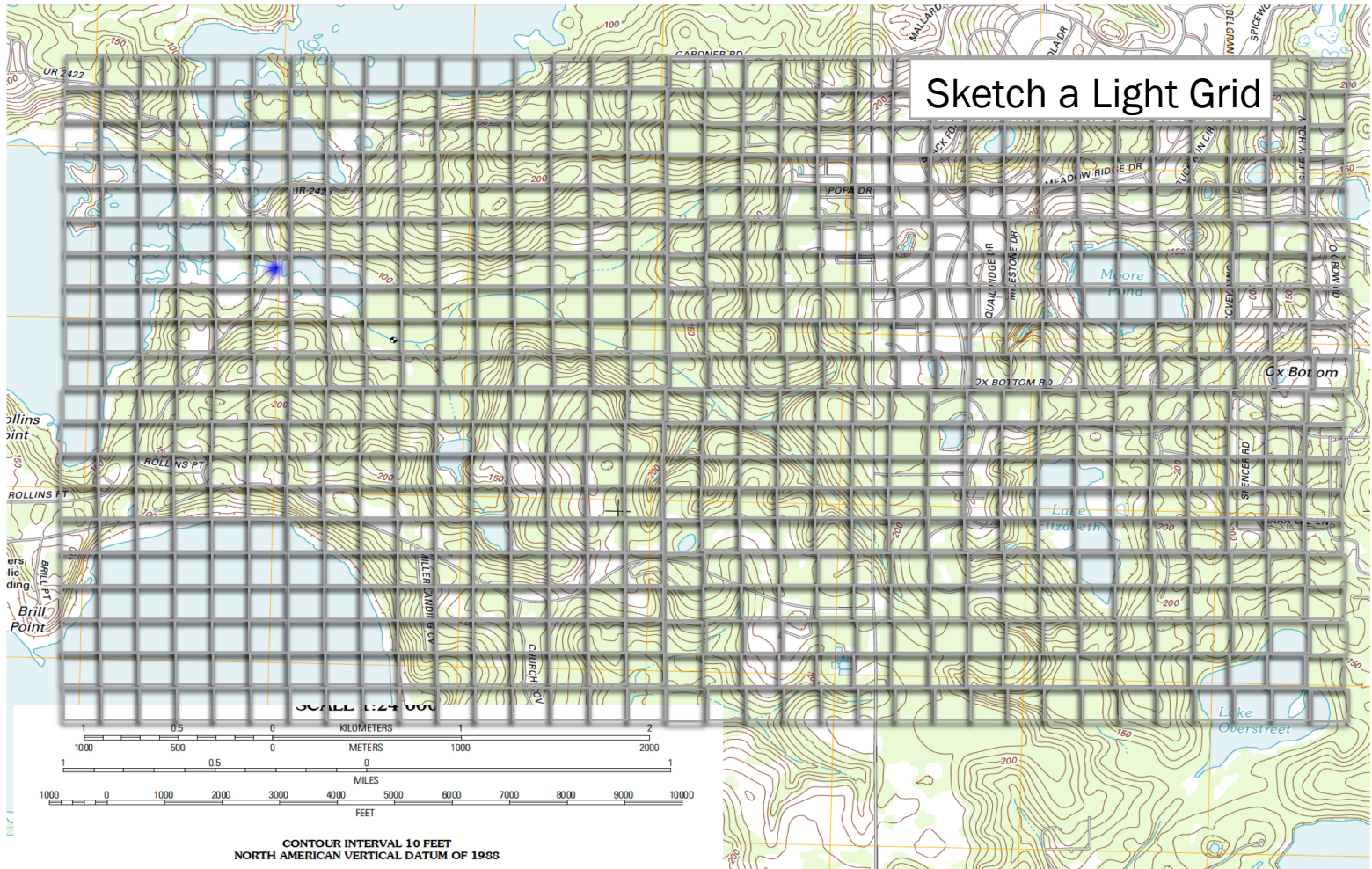
WATERSHED DELINEATION

↗ Identifies the boundaries of our hydrologic unit / area of study.

   ↗ Need to interpret topographic maps (or DEM/DTM) to construct the boundary

   ↗ Steps to manual delineation

      ↗ Superimpose a grid to estimate average elevations

      ↗ Trace/outline outline the main stem of the stream that you want to examine

      ↗ Trace all perennial or influential tributaries

      ↗ Locate the lowest point/outlet of the main stem and work uphill
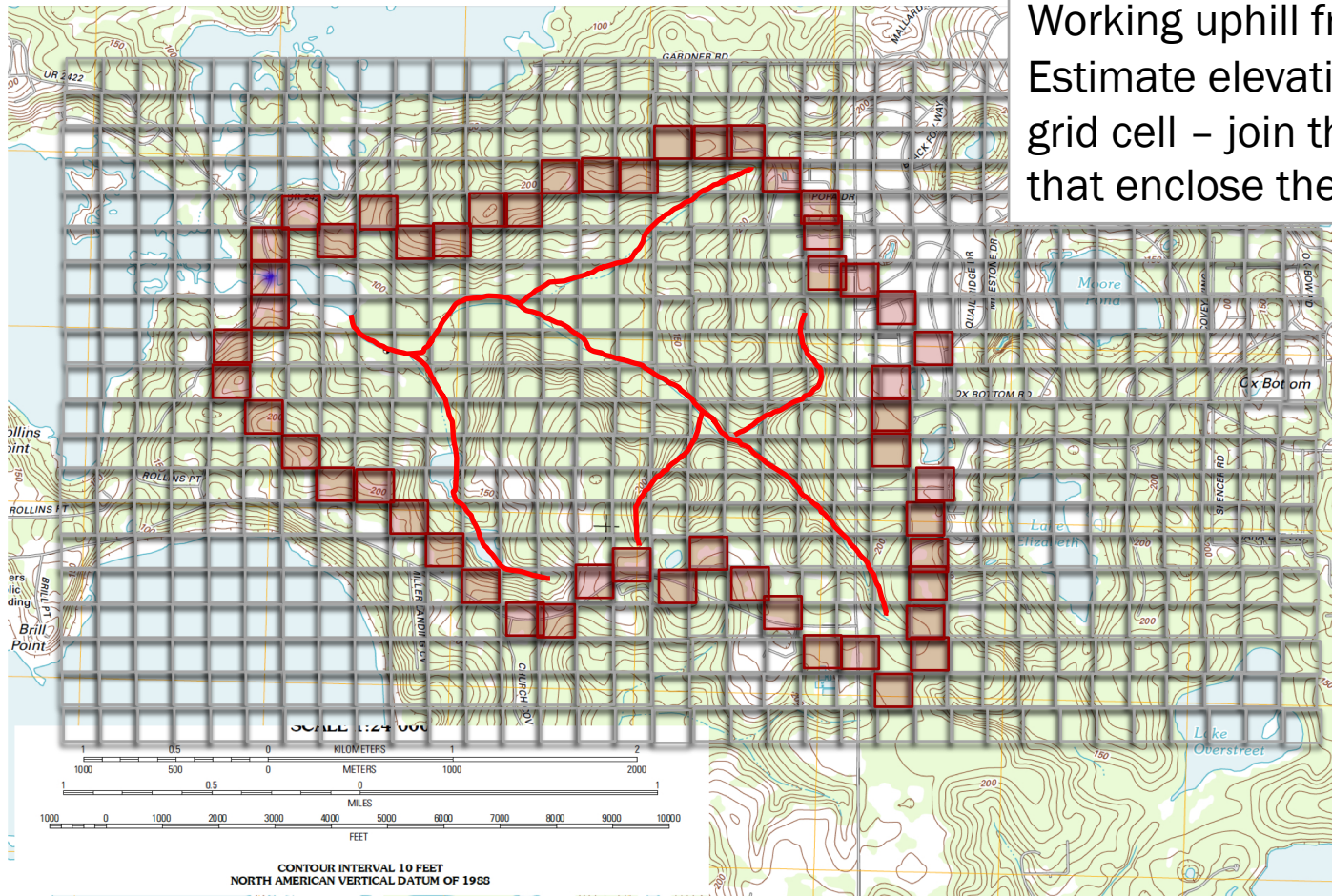
WATERSHED DELINEATION

Locate Outlet

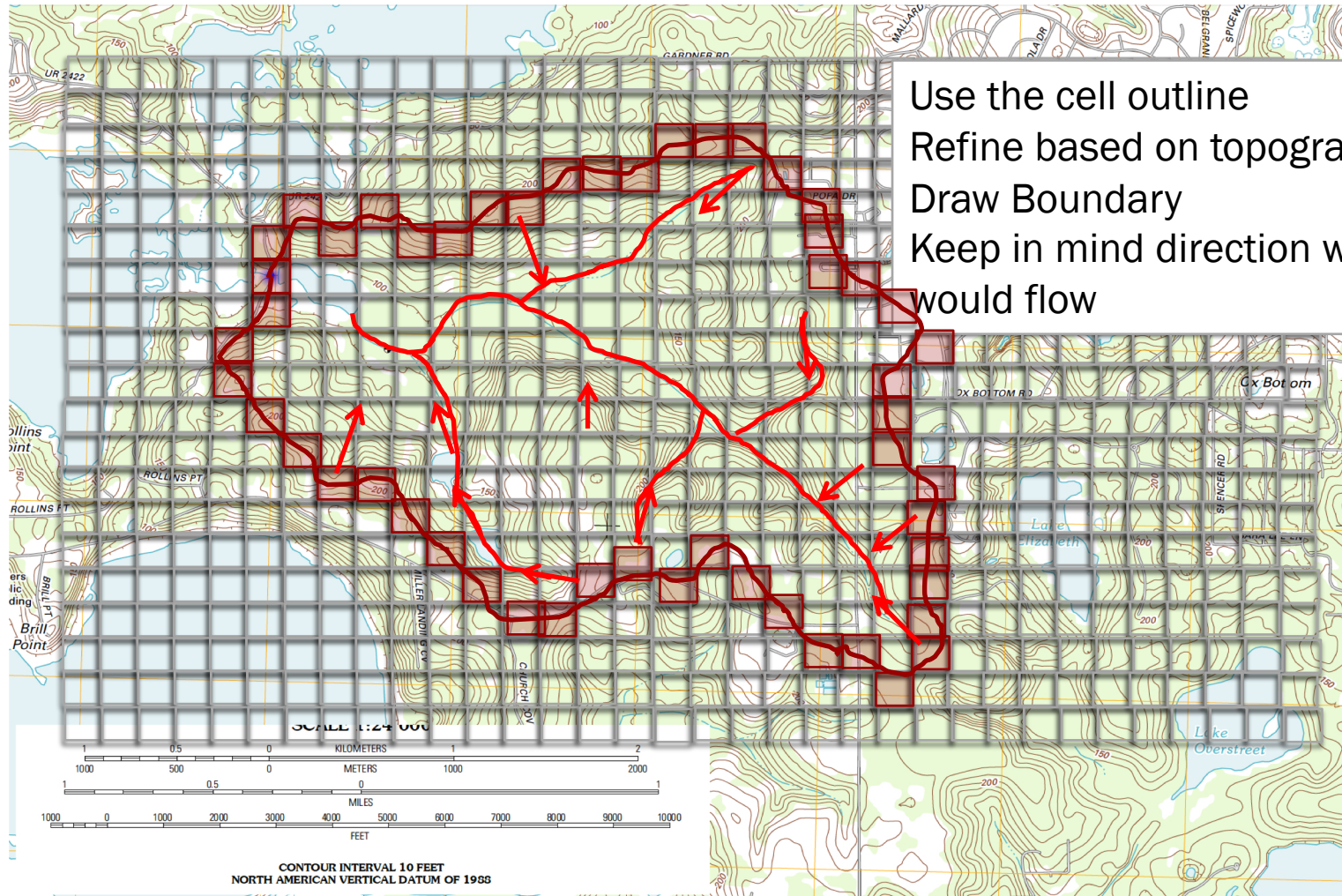# WATERSHED DELINEATION

Sketch a Light Grid
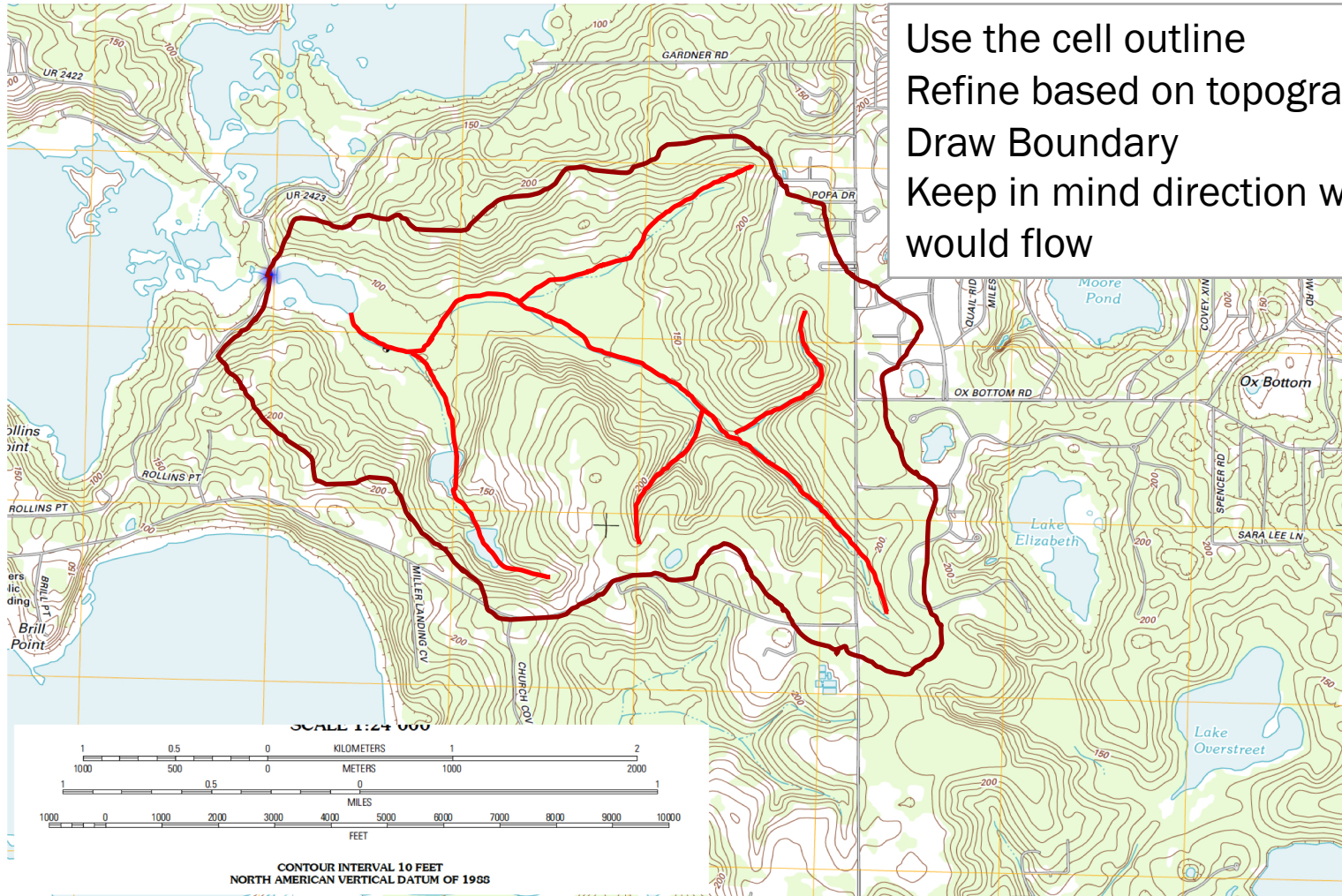
WATERSHED DELINEATION

Working uphill from outlet
Estimate elevations in each grid cell – join the high cells that enclose the outlet

WATERSHED DELINEATION

Use the cell outline
Refine based on topography
Draw Boundary
Keep in mind direction water would flow

WATERSHED DELINEATION

Use the cell outline
Refine based on topography
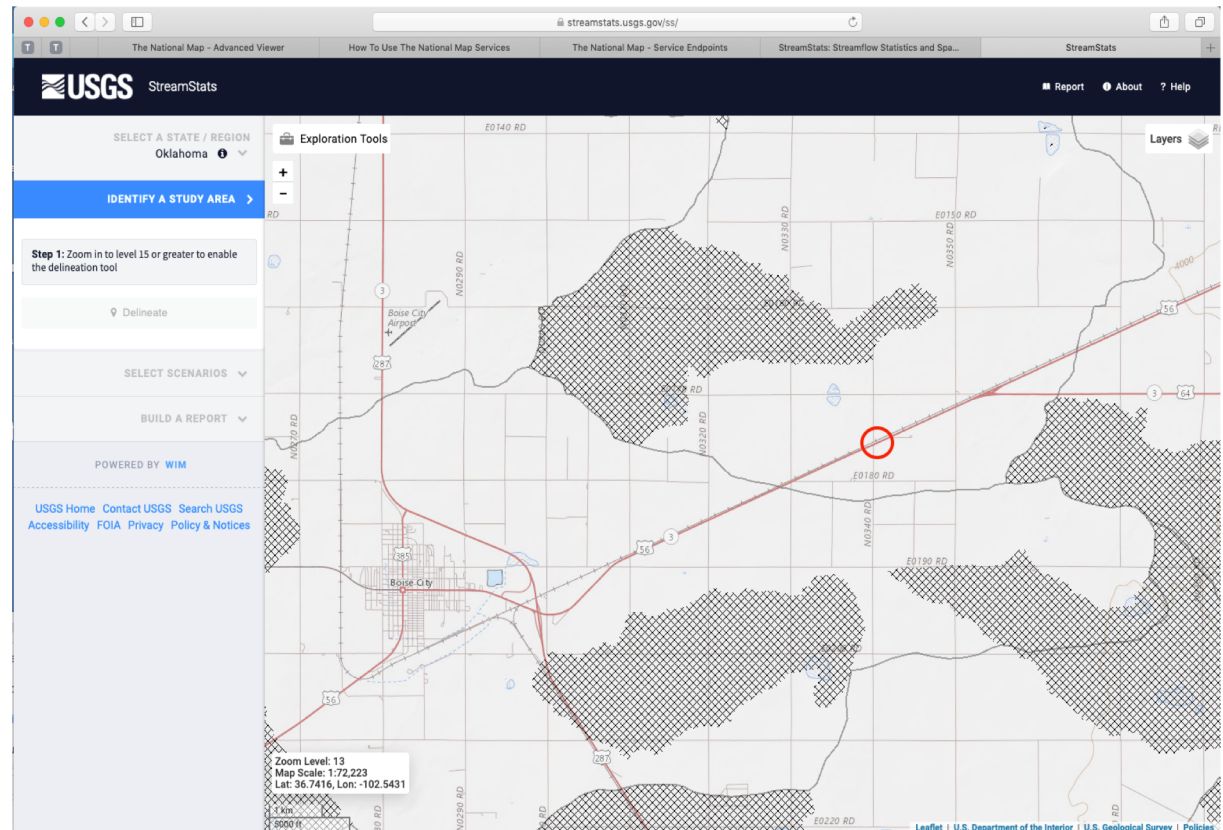Draw Boundary
Keep in mind direction water would flow

WATERSHED DELINEATION USING STREAM STATS

↗ An online tool that can identify a watershed is the USGS StreamStats (https://streamstats.usgs.gov/ss/) tool

Consider a project in Oklahoma. The red circle indicates the project location. The circle lies on a stream that is crossed by the project – perhaps a culvert or similar hydraulic structure.

For watershed mitigation strategies to be employed, it is useful to know what the upstream drainage area is relative to the project.
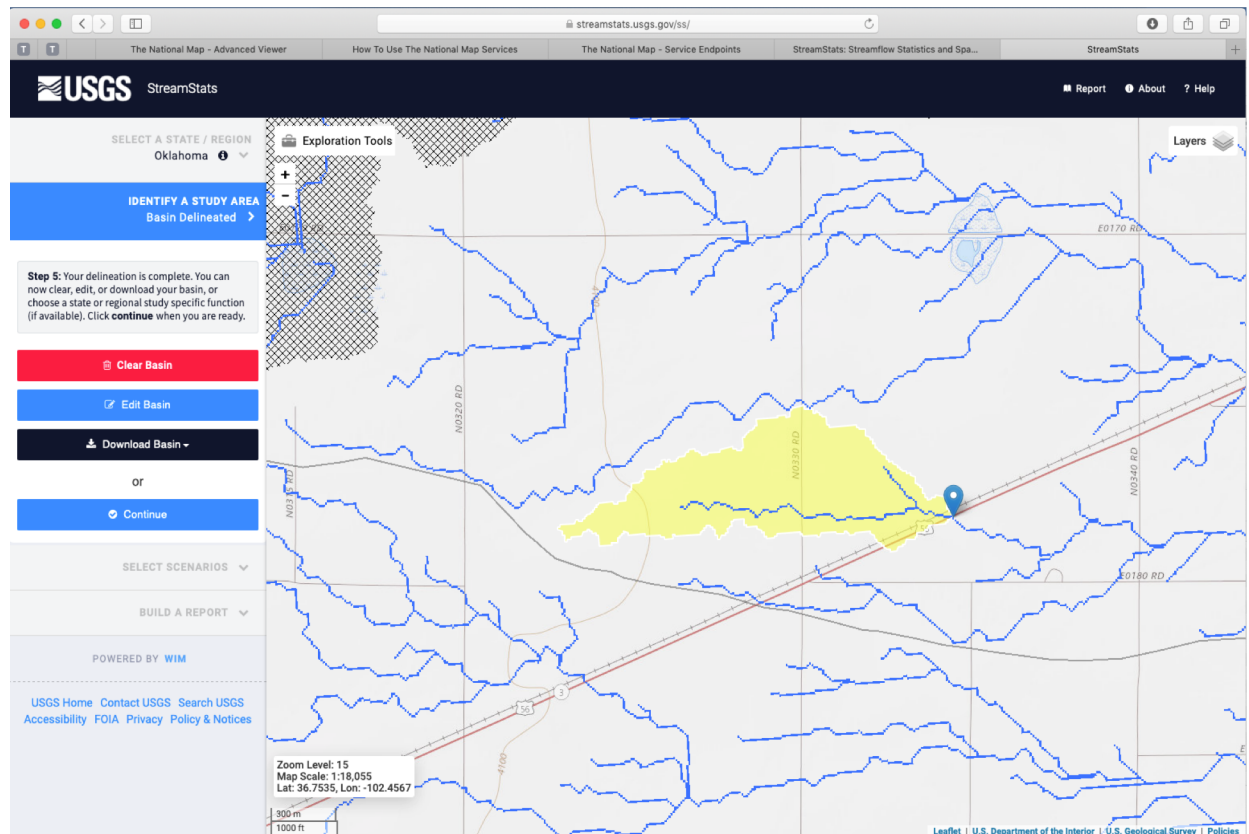
WATERSHED DELINEATION USING STREAM STATS

↗ An online tool that can identify a watershed is the USGS StreamStats (https://streamstats.usgs.gov/ss/) tool

To the right is a screen capture of the StreamStats delineated watershed, UPSTREAM of the project location.

The next step is to download the shapefile bundle and process for various watershed metrics; important in the bundle is the boundary, which can be used to obtain an elevation model

WATERSHED DELINEATION USING STREAM STATS

↗ Within any of the identified watersheds (yellow areas) a set of physical metrics is available, some examples are:

  ↗ outlet elevation (the pour point identified by the location selection!),

  ↗ various precipitation values, including mean annual,

  ↗ composite soil permeability,

  ↗ 10-85 channel slope, mean basin slope from 10-meter DEM.

  ↗ As important, the shape file is generated so that analysts can use it as a boundary file to extract an elevation raster from the National Elevation Dataset (embedded within the National Map).

  ↗ In the present context this is the link that can allow for effective hydrologic model construction.

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WATERSHED DELINEATION USING STREAM STATS

↗ Available coverages – Texas is excluded.

- To the right is a map that depicts the status of the StreamStats toolkit.
- Most of the United States is fully implemented, the exceptions are Texas, Florida, Nevada, Nebraska, and Michigan.
- In these states, the stated reason for exclusion is insufficient funding to implement the tool (the data exist and are safely archived at the USGS).
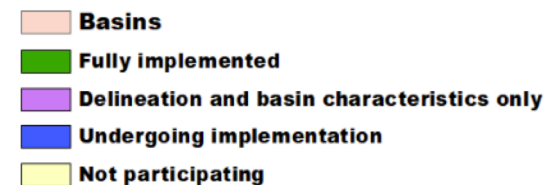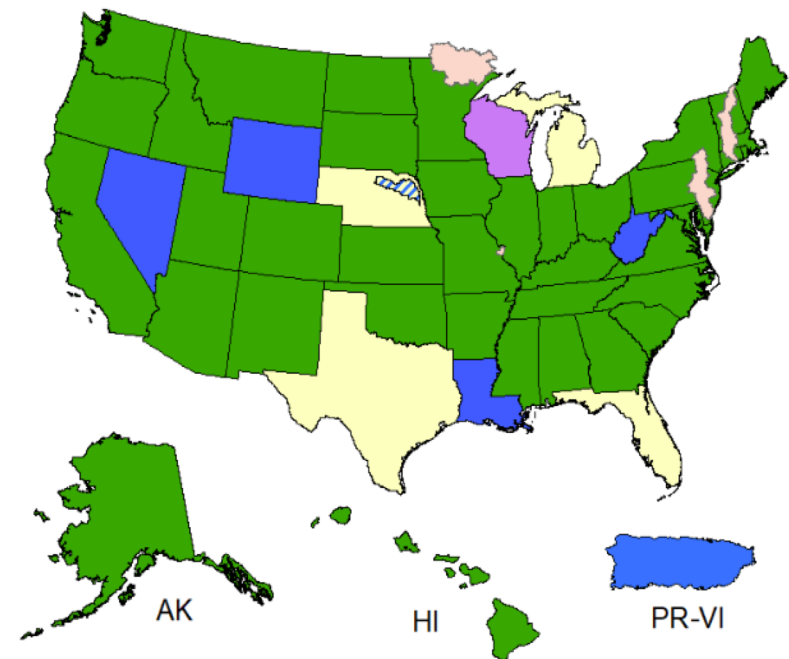
U.S. Geological Survey, 2019, The National Map—New data delivery homepage, advanced viewer, lidar visualization: US. Geological Survey Fact Sheet 2019–3032, 2 p., https://doi.org/10.3133/fs20193032.

Ries, K.G., III, Newson J.K., Smith, M.J., Guthrie, J.D., Steeves, P.A., Haluska, T.L., Kolb, K.R., Thompson, R.F., Santoro, R.D., and Vraga, H.W., 2017, StreamStats, version 4: U.S. Geological Survey Fact 2017–3046, 4 p., https://doi.org/10.3133/fs20173046. [Supersedes USGS Fact Sheet 2008–3067.]

Basins
Fully implemented
Delineation and basin characteristics only
Undergoing implementation
Not participating

WATERSHED METRICS

↗ The fundamental unit in surface water hydrology is the watershed.

↗ A watershed is defined as the area on the surface of the earth that drains to a specific location.

  ↗ Watershed properties include:
    ↗ Area
    ↗ Main channel length
    ↗ Slope (requires the specification of path),
    ↗ Soil moisture/permeability

AFTER DELINEATION

➚ Watershed physical and descriptive characteristics determined after delineation include:

➚ Areas
➚ Lengths
➚ Slopes (along defined paths)
➚ Cover type
➚ Soil properties

HARDEN BRANCH WATERSHED

HARDEN BRANCH WATERSHED
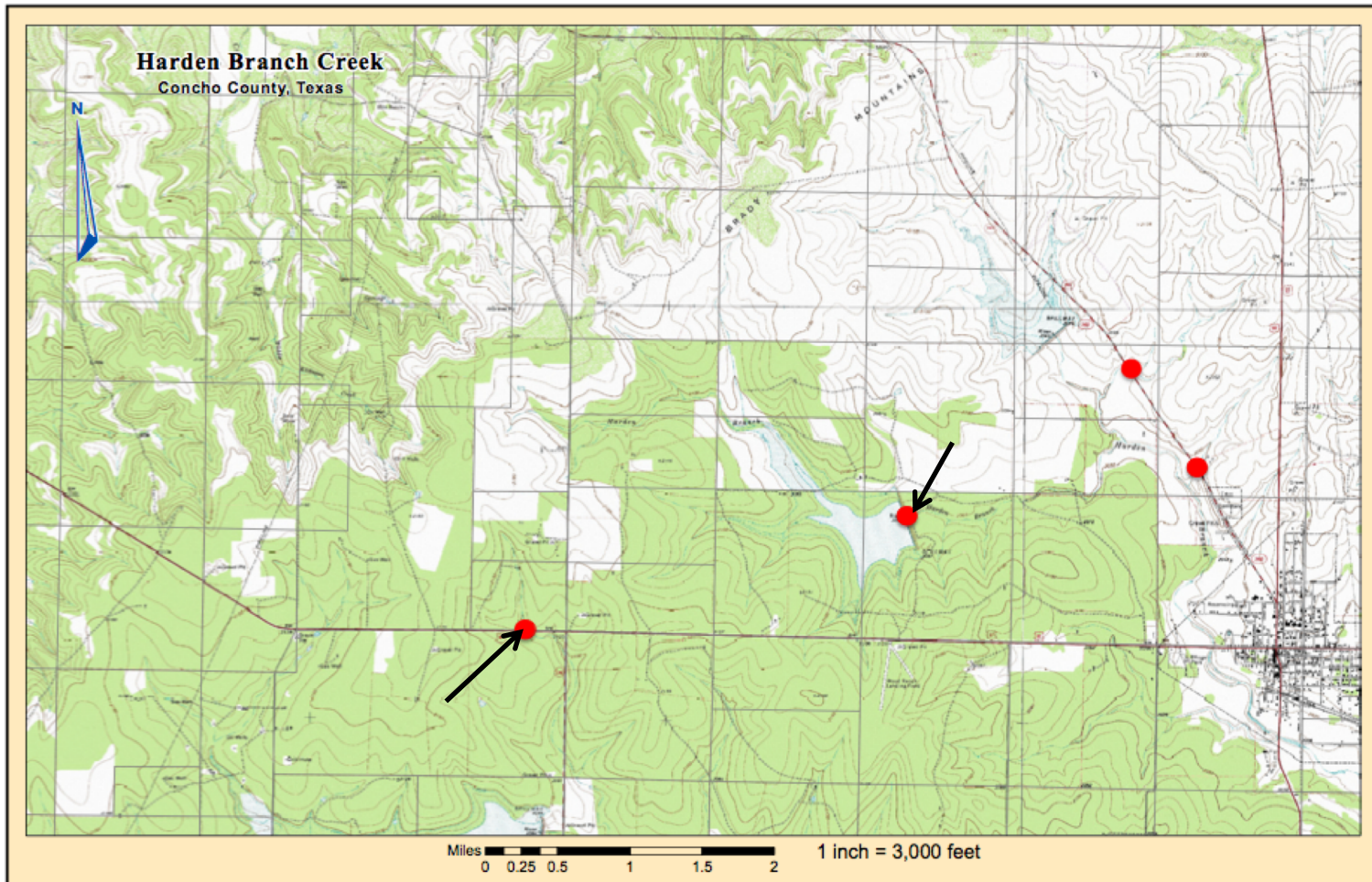
Harden Branch Creek
Concho County, Texas
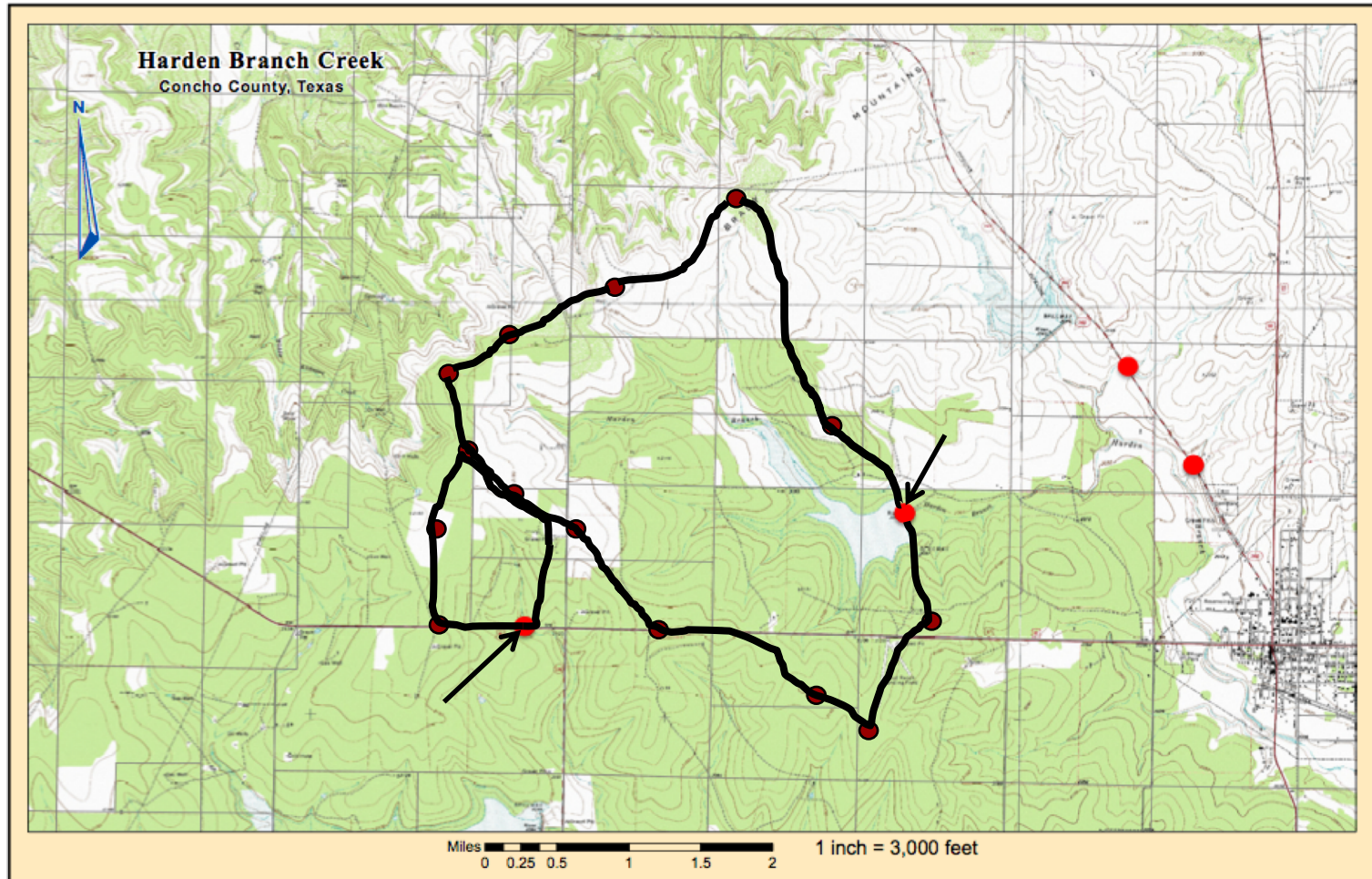
WATERSHED METRICS

- How to measure area
  - Numerical Planimetery
    - Arc GIS
    - AutoCad (Polygon Area)
    - Acrobat Pro (Measuring Tools)
    - Surfer
    - ENGAUGE
    - G3DATA+PolyArea.xls
  - Mechanical Planimetery
  - Count squares

- How to measure lengths
  - ArcGIS
  - AutoCad
  - Acrobat Pro
  - Surfer
  - ENGAUGE
  - G3DATA
  - By-hand

WATERSHED METRICS

➚ How to find soil properties

➚ Web Soil Survey

➚ Soil Maps

WATERSHED METRICS

↗ How to find soil properties

  ↗ Web Soil Survey

  ↗ Soil Maps

WATERSHED METRICS

↗ How to estimate %-impervious/developed

   ↗ Google Earth

      ↗ Find area of interest

      ↗ Select a viewing height (needs to be same if have to scroll)

      ↗ Put a grid on the screen (physical grid on see-thru plastic)

      ↗ Count concrete vs not concrete – relative ratio is a useable estimate of the %-impervious

MINIMAL WATERSHED DESCRIPTION

↗ Watershed boundary on a map
  - ↗ Area that drains to the outlet (AREA)
  - ↗ Main Channel Length (MCL)
  - ↗ Slope(s)
  - ↗ Soil Properties (Permeability)
  - ↗ %-Impervious