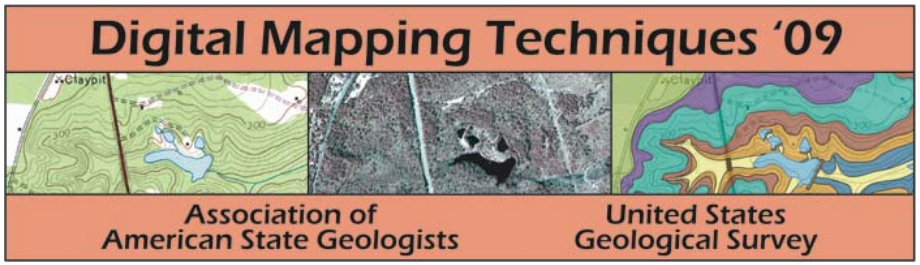


The following was presented at DMT'09 (May 10-13, 2009).

The contents are provisional and will be superseded by a paper in the DMT'09 Proceedings.

See also earlier Proceedings (1997-2008)
http://ngmdb.usgs.gov/info/dmt/

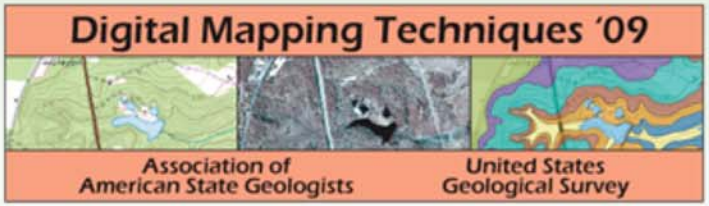
Lidar based DEM slope-shapes – seeing through the canopy

Thomas G. Whitfield, P.G.

Pennsylvania Geological Survey

DMT 2009

Morgantown, WV



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PAMAP lidar program

- Statewide program
- Generates a very detailed DEM (digital elevation model)
- Pixel resolution is 3.2 feet (~1 meter)
- 10,000-foot grid tile for whole state
- Flown in conjunction with high-resolution full color aerial imagery (1-foot pixels)

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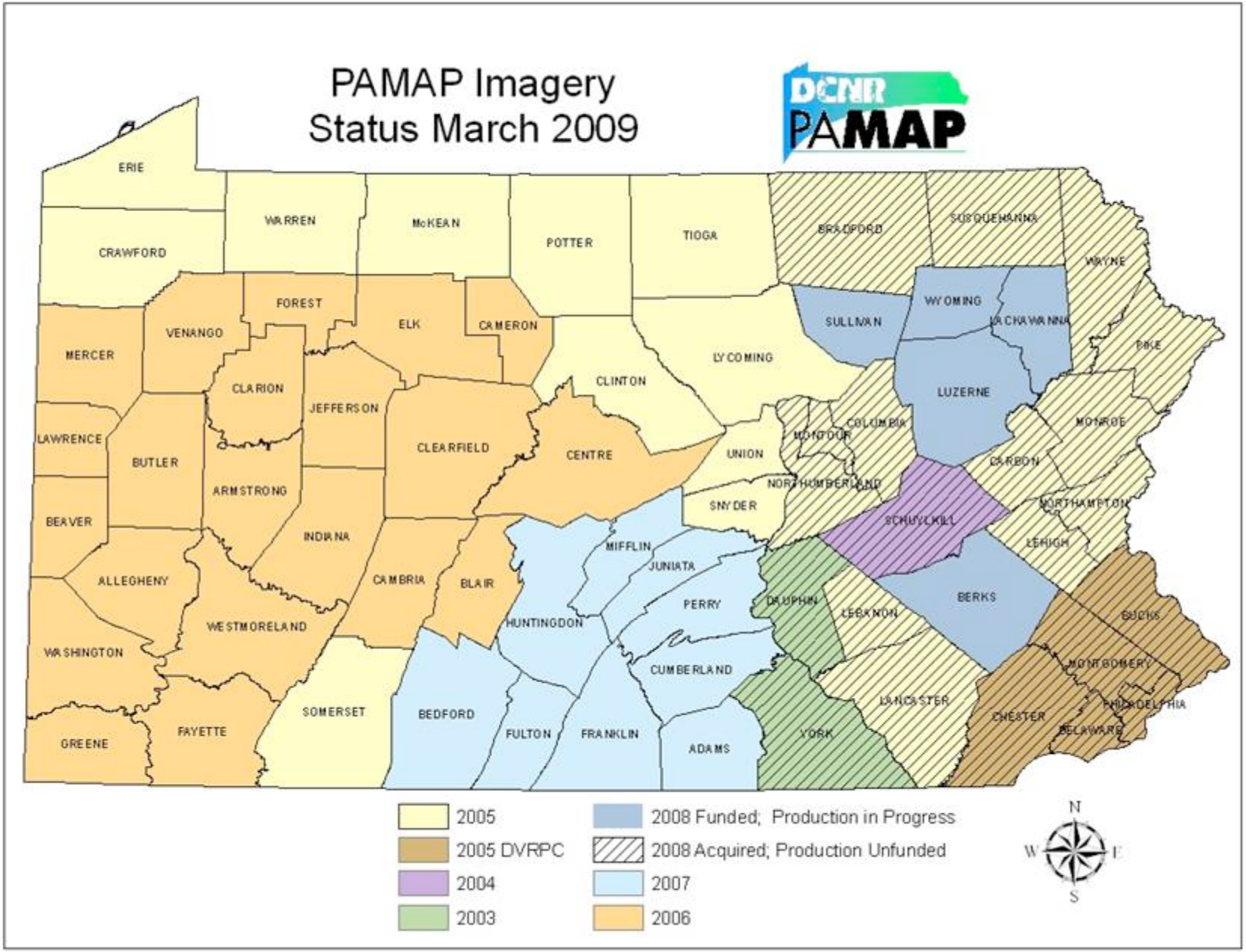
PAMAP Imagery
Status March 2009
DCNR
PAMAP
ERIE
CRAWFORD
WARREN
McKEAN
POTTER
TIOGA
BRADFORD
SUSQUEHANNA
WAYNE
MERCER
VENANGO
FOREST
ELK
CAMERON
SULLIVAN
WYOMING
LACKAWANNA
PIKE
CLARION
JEFFERSON
CLINTON
LYCOMING
LUZERNE
LAWRENCE
BUTLER
CLEARFIELD
CENTRE
MONTOUR
COLUMBIA
MONROE
UNION
CARBON
ARMSTRONG
NORTHUMBERLAND
BEAVER
INDIANA
SNYDER
SCHUYLKILL
NORTHAMPTON
MIFFLIN
LEHIGH
ALLEGHENY
CAMBRIA
BLAIR
JUNIATA
PERRY
DAUPHIN
BERKS
BUCKS
WASHINGTON
WESTMORELAND
HUNTINGDON
LEBANON
CUMBERLAND
MONTGOMERY
SOMERSET
BEDFORD
FULTON
FRANKLIN
ADAMS
YORK
LANCASTER
CHESTER
PHILADELPHIA
DELAWARE
GREENE
FAYETTE
2005
2005 DVRPC
2004
2003
2008 Funded; Production in Progress
2008 Acquired; Production Unfunded
2007
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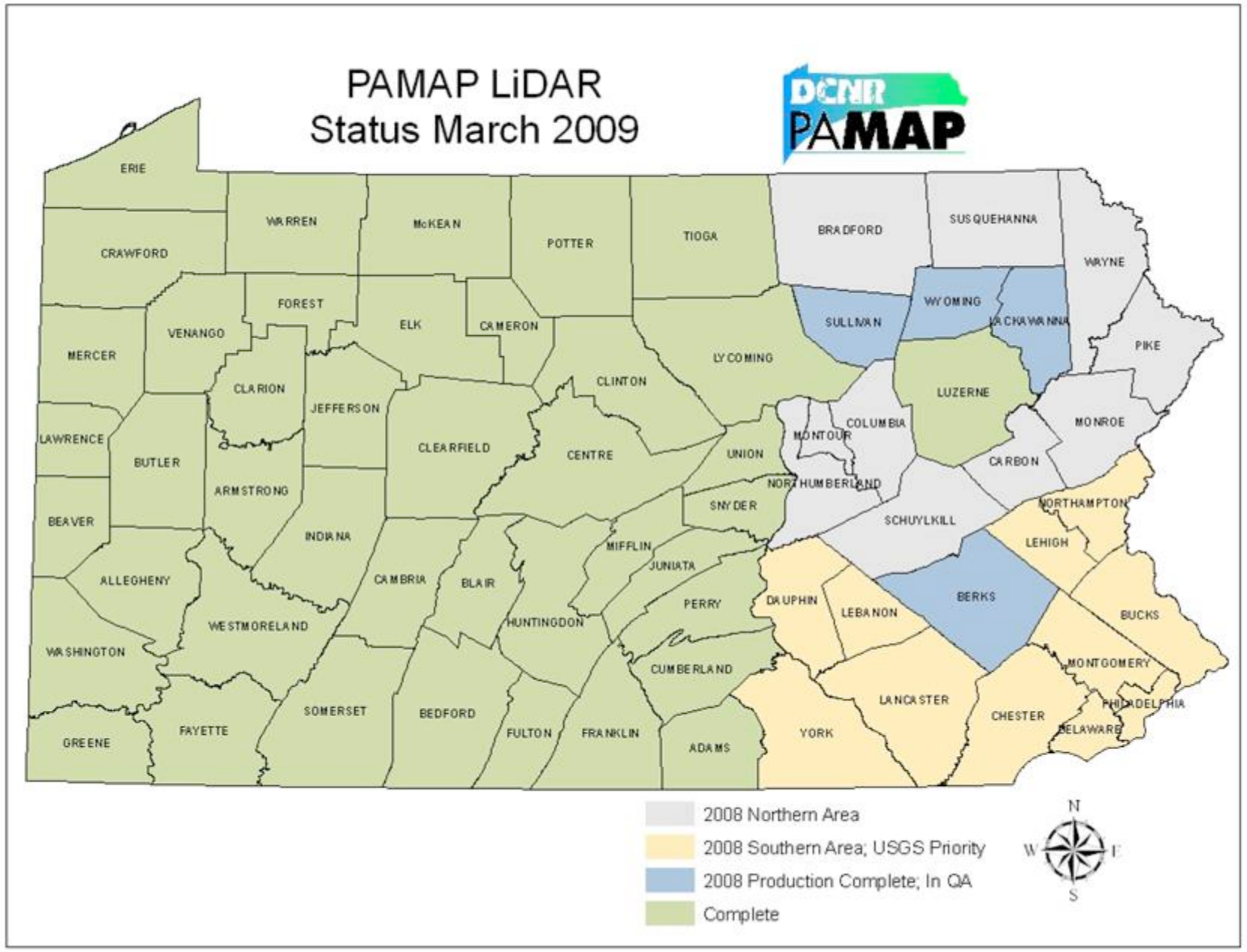
PAMAP LiDAR
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BERKS
BUCKS
WESTMORELAND
HUNTINGDON
WASHINGTON
CUMBERLAND
MONTGOMERY
LANCASTER
CHESTER
PHILADELPHIA
DELAWARE
SOMERSET
BEDFORD
FULTON
FRANKLIN
ADAMS
YORK
GREENE
FAYETTE
2008 Northern Area
2008 Southern Area; USGS Priority
2008 Production Complete; In QA
Complete
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PAMAP lidar program

- Aerial imagery flown between 2004 – 2008 covers the entire state and is available for download from PASDA
- Lidar for entire state has been acquired, but parts have not been processed (no $$)
- Actively engaged in seeking funding to finish processing

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Lidar review

- Lots of processing ($$$) and filtering
- Multiple derivative products
- Lots of uses
- We are interested in the “bare earth” or “last returns” model
- Our lidar derived DEM is a 32-bit, floating point GRID with 3.2-foot pixel resolution

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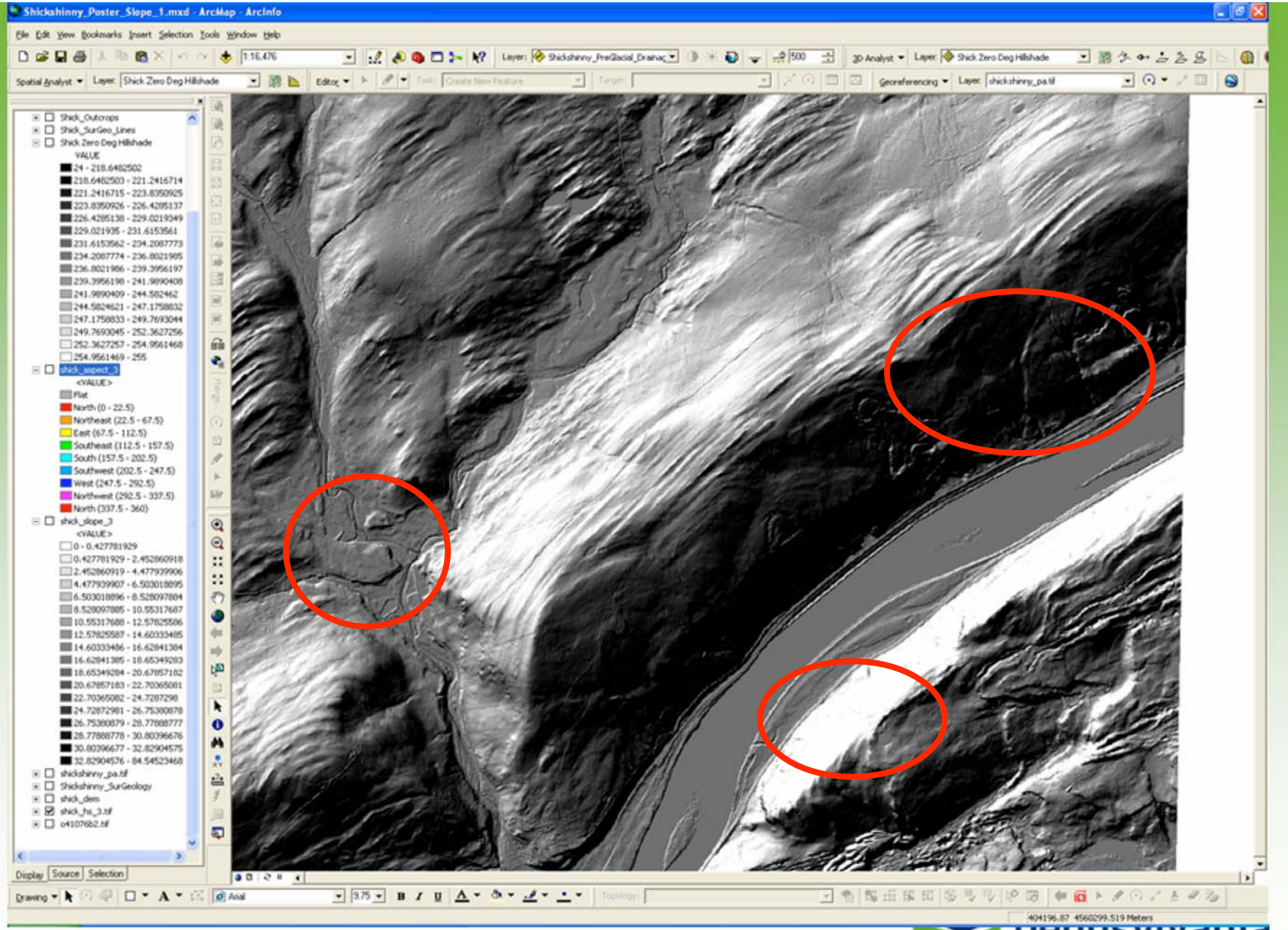
The (In)famous hillshade

- The first thing everyone tries
- Wow factor – lots of Oooos and Ahhhs…
- BUT, take a good look….

- Details get lost in “bright sunlit” areas and “dark shadow” areas



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Hillshade continued

- One solution, multiple hillshades with varied sun azimuth and altitudes
- Can’t see everything at once
- Your “mind’s eye” inverts things
- Can’t remember which grid shows what or where it you put it (us older people)
- Lots of disk space cost

The slope-shape

- Ralph Haugerud of the USGS introduced the slope-shape concept at DMT 2008 in Moscow, Idaho
- Differs from a hillshade – slope, aspect, sun azimuth, sun angle are used in an algorithm to compute grayscale "sun/shadow" values (0 – 256)
- Slope-shape is simply a slope grid generated from a DEM

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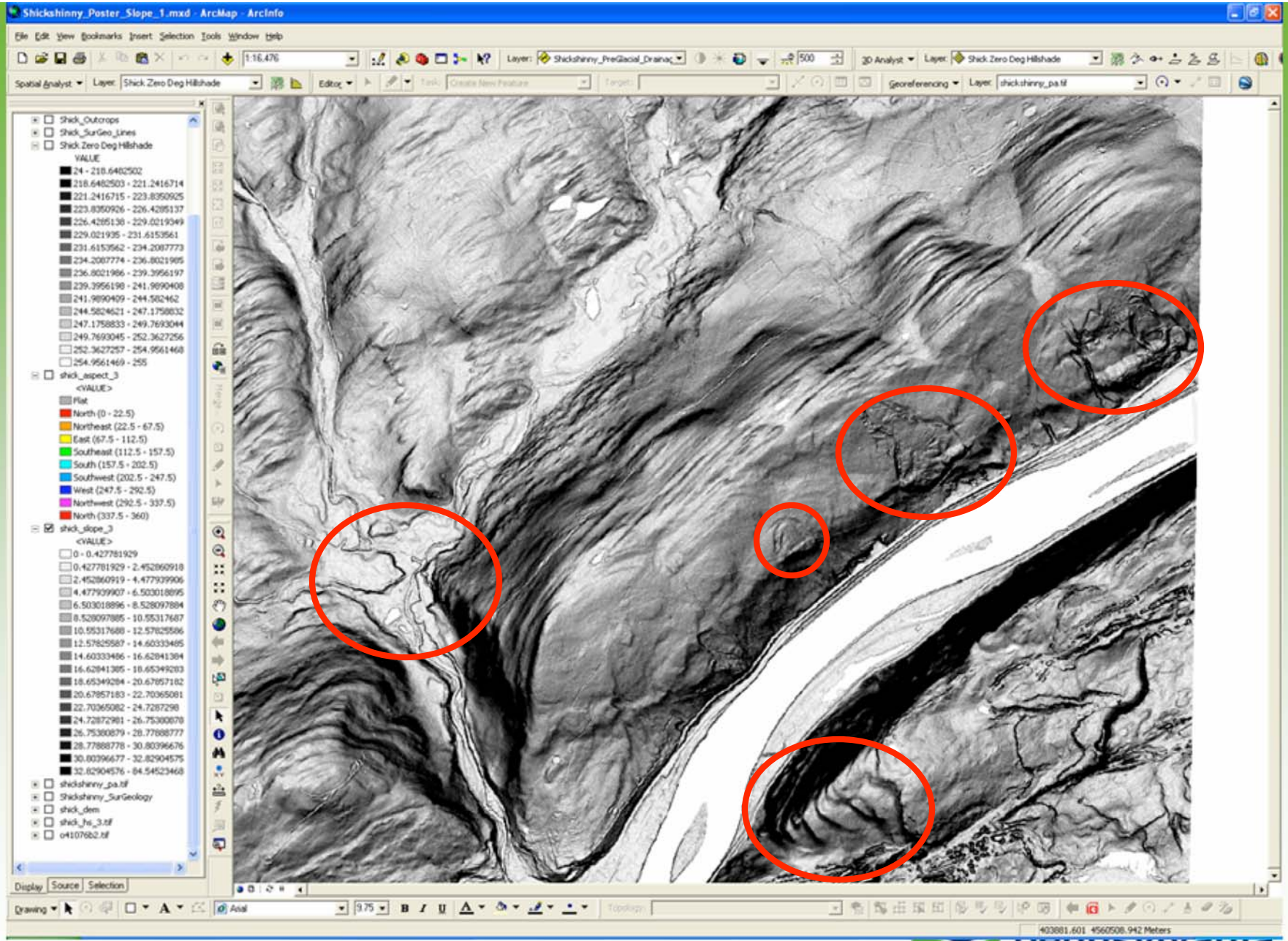

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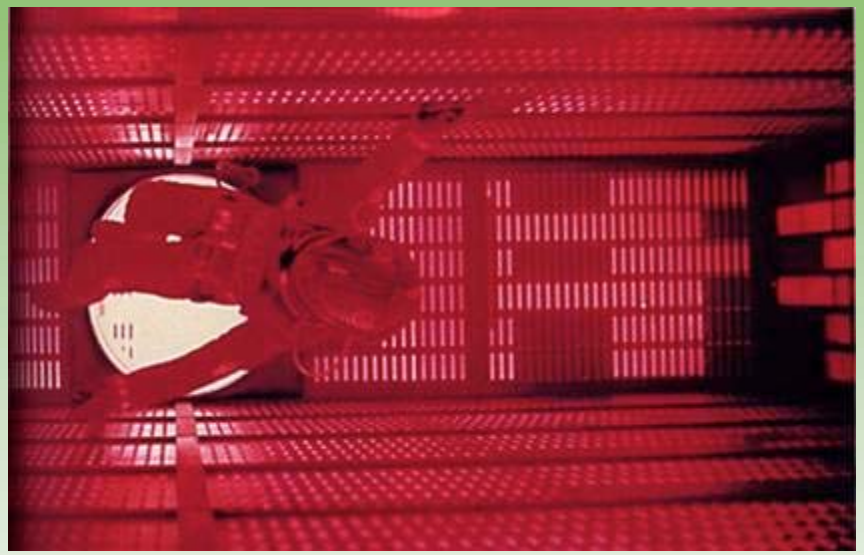
Slope-shape – “How to’s”

- Ain’t rocket science
- Easy to create
- Easy to display – most important part
- Easy to interpret
- One grid to track
- No right way, no wrong way, but there is always the…..



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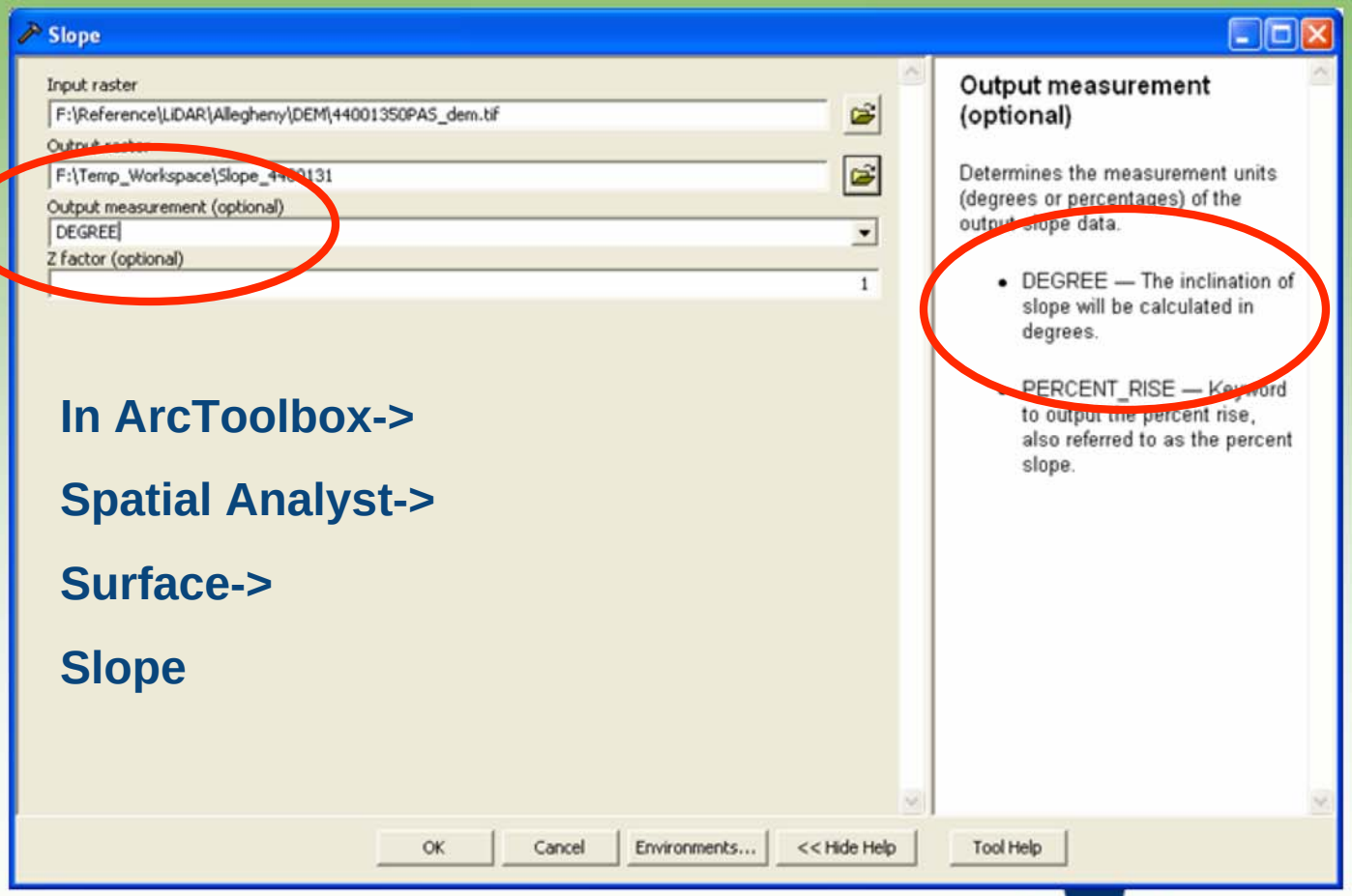
GOV'T WAY

Create a slope grid



In ArcToolbox->

Spatial Analyst->

Surface->

Slope

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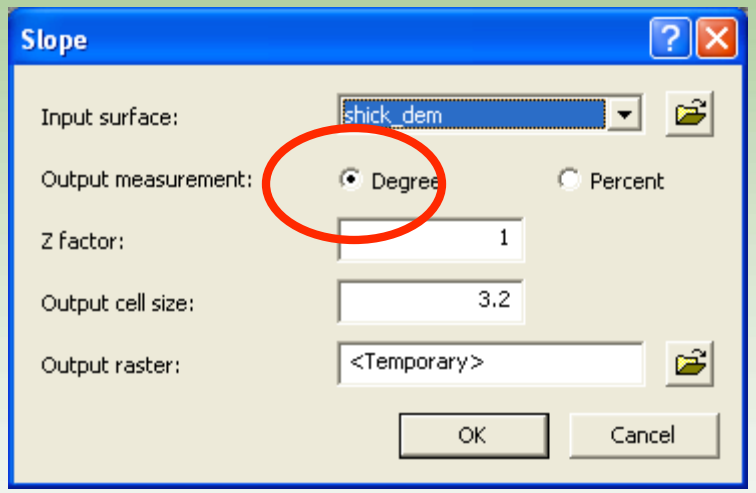
Alternative slope creation method

In ArcMap->

Spatial Analyst->

Surface Analysis->

Slope



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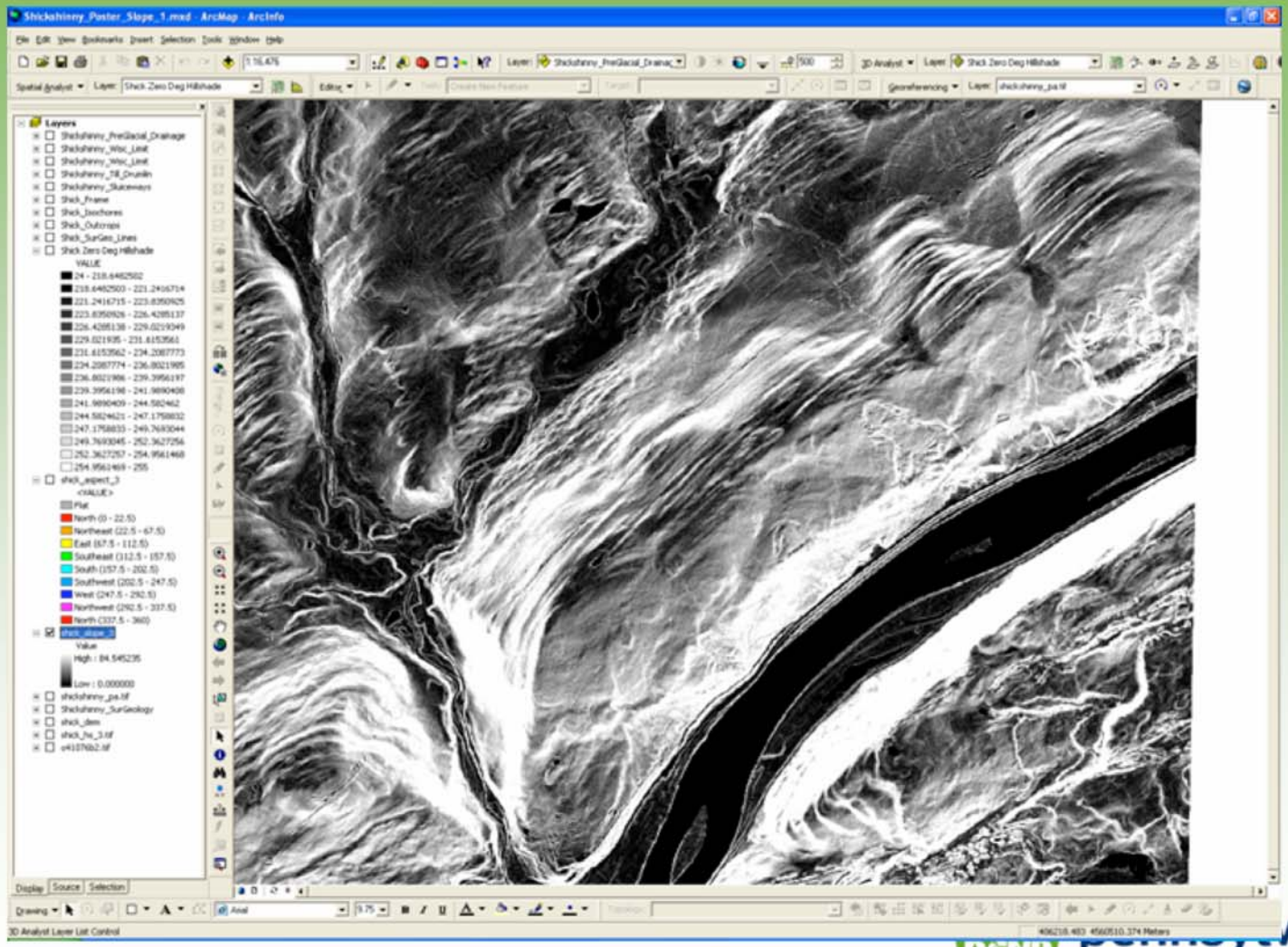
Not a pretty result – but that's okay



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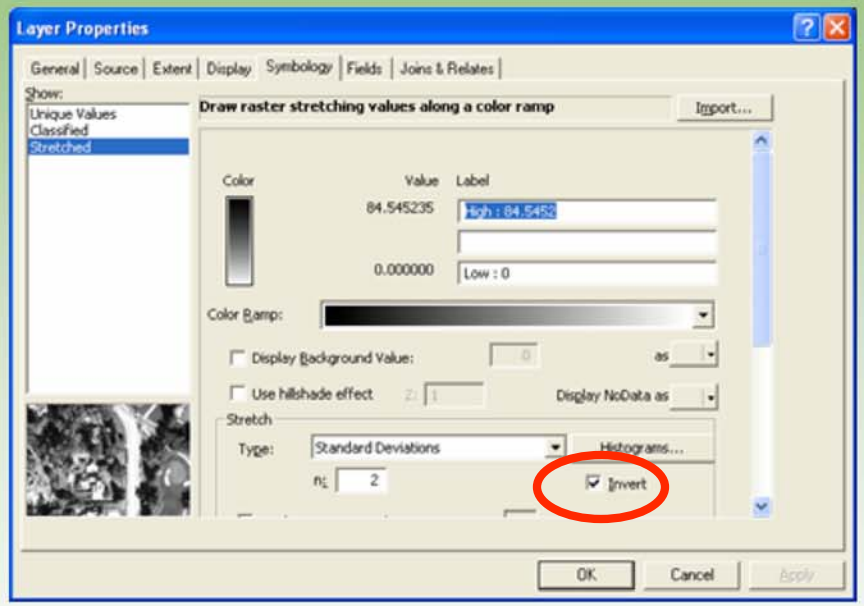
Resetting the display

- To get the most out of this, we need to reset the display
- Inverting the color ramp helps, but not enough contrast



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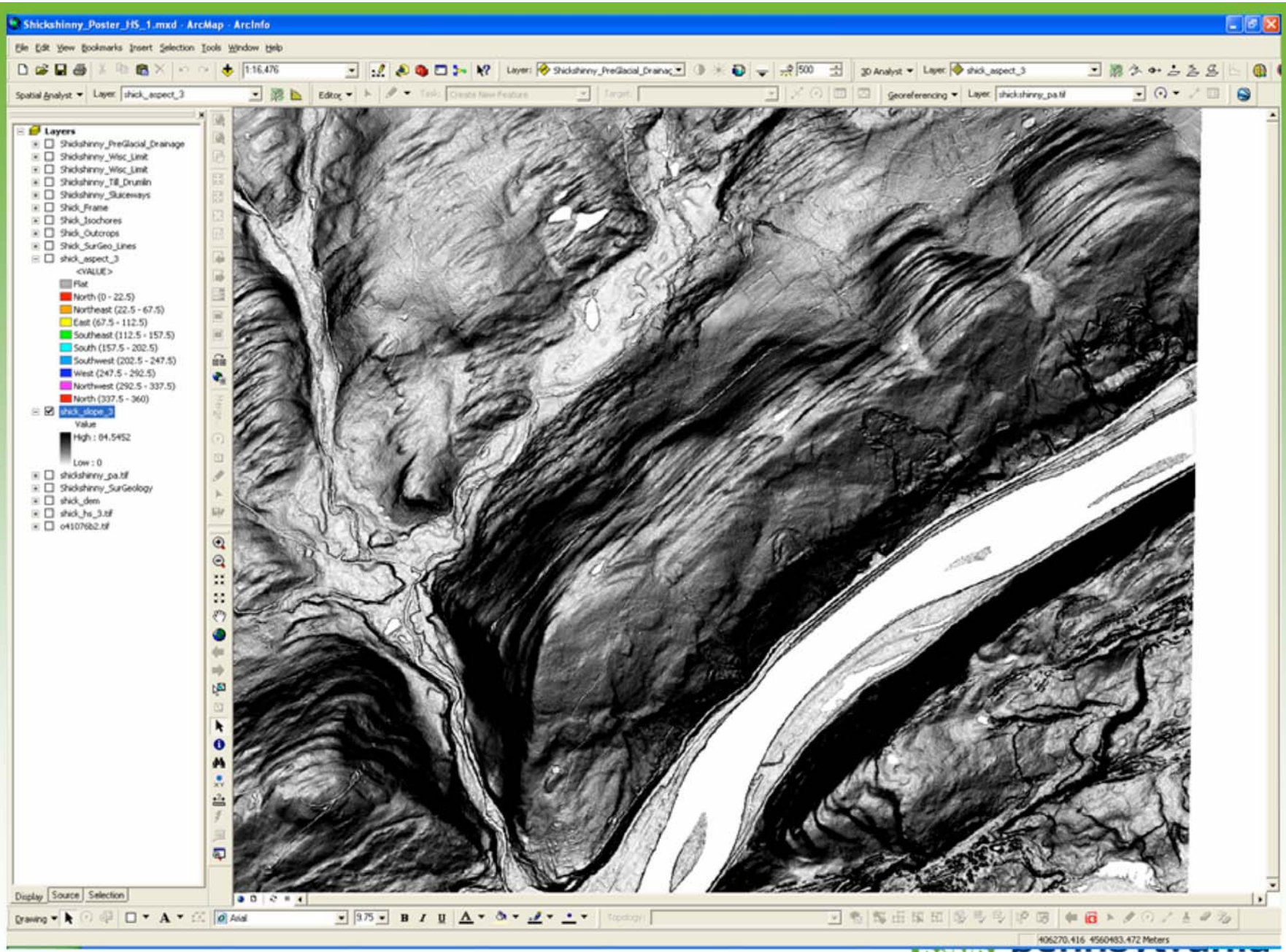

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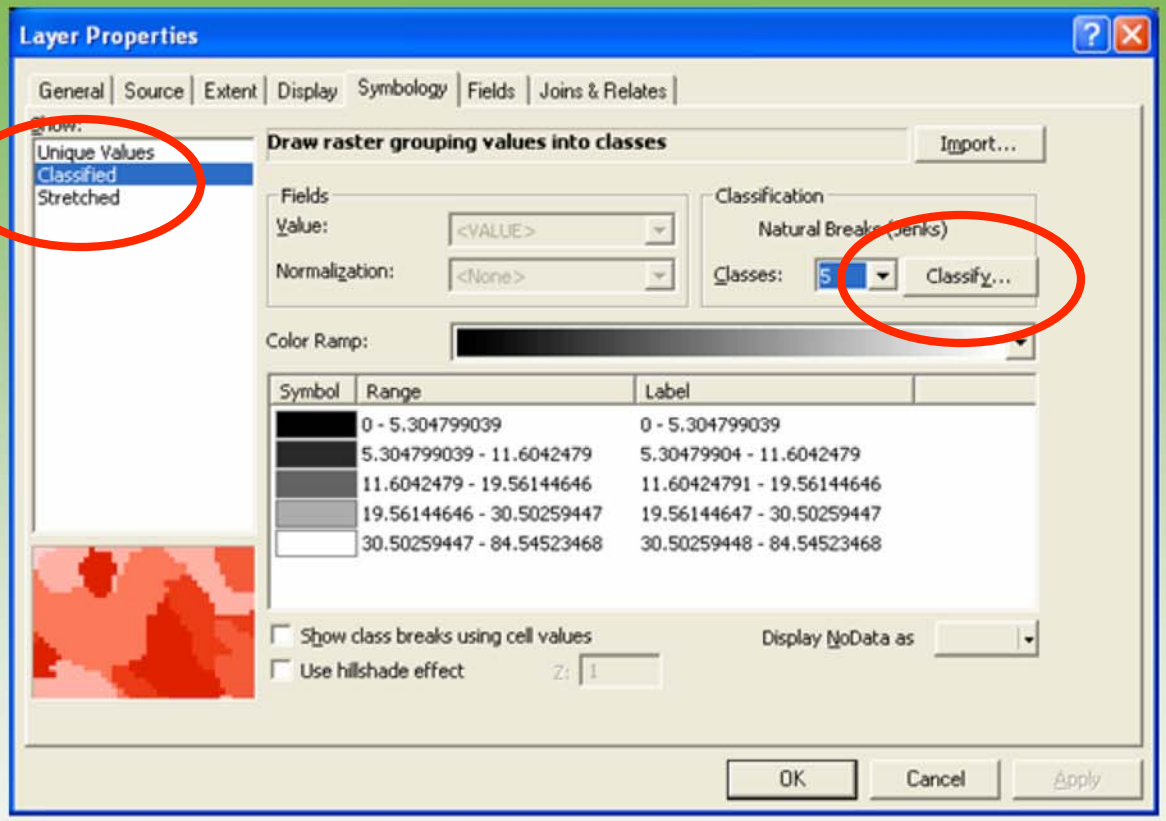
Resetting the display

- Want to get most contrast across the low end of the display range (0° to ~30°)
- Want to set the flat and nearly flat areas to white and near-vertical to black
- Switch from a stretched display to a classified display



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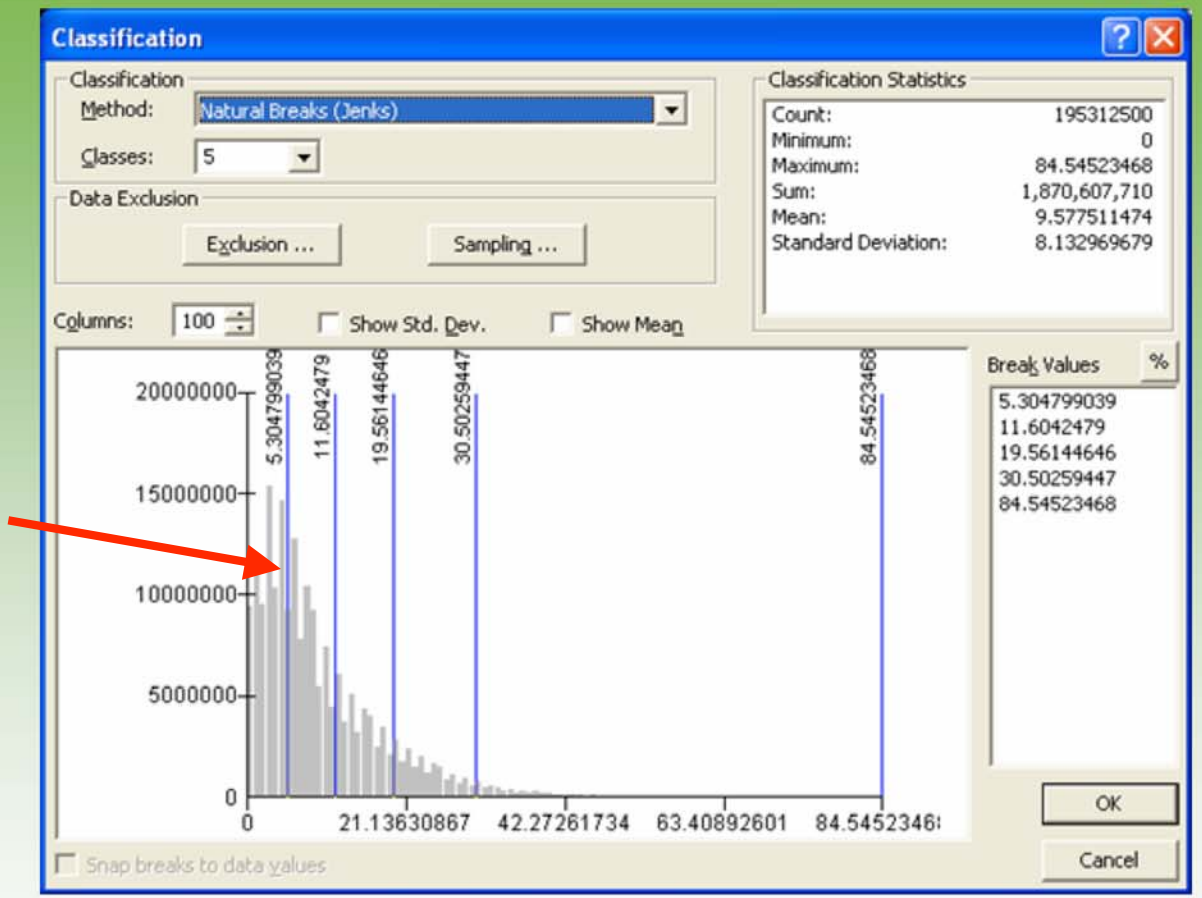
Want to get more divisions across the bell part of the histogram



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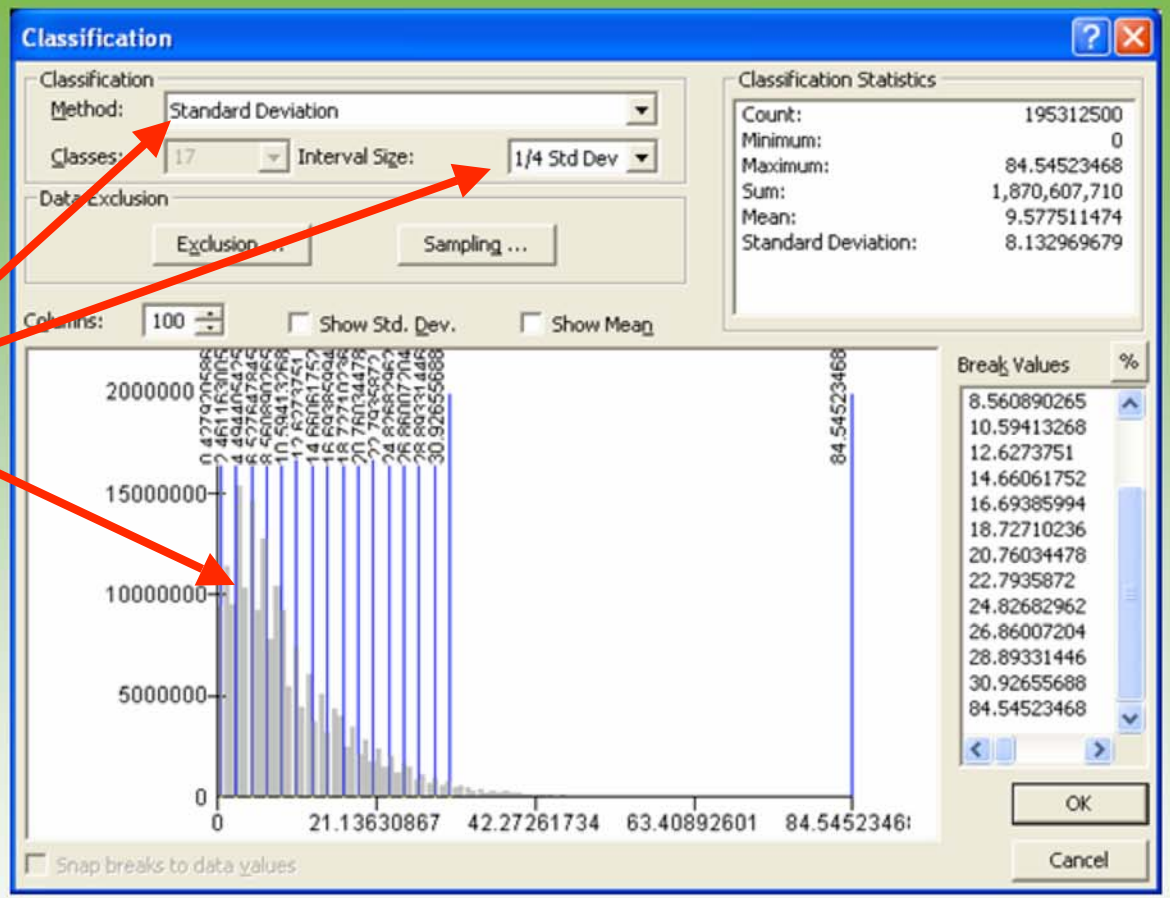
A standard deviation and 1/4 interval size gives a nice spread over the bell curve

Works well for moderate to moderately high relief areas



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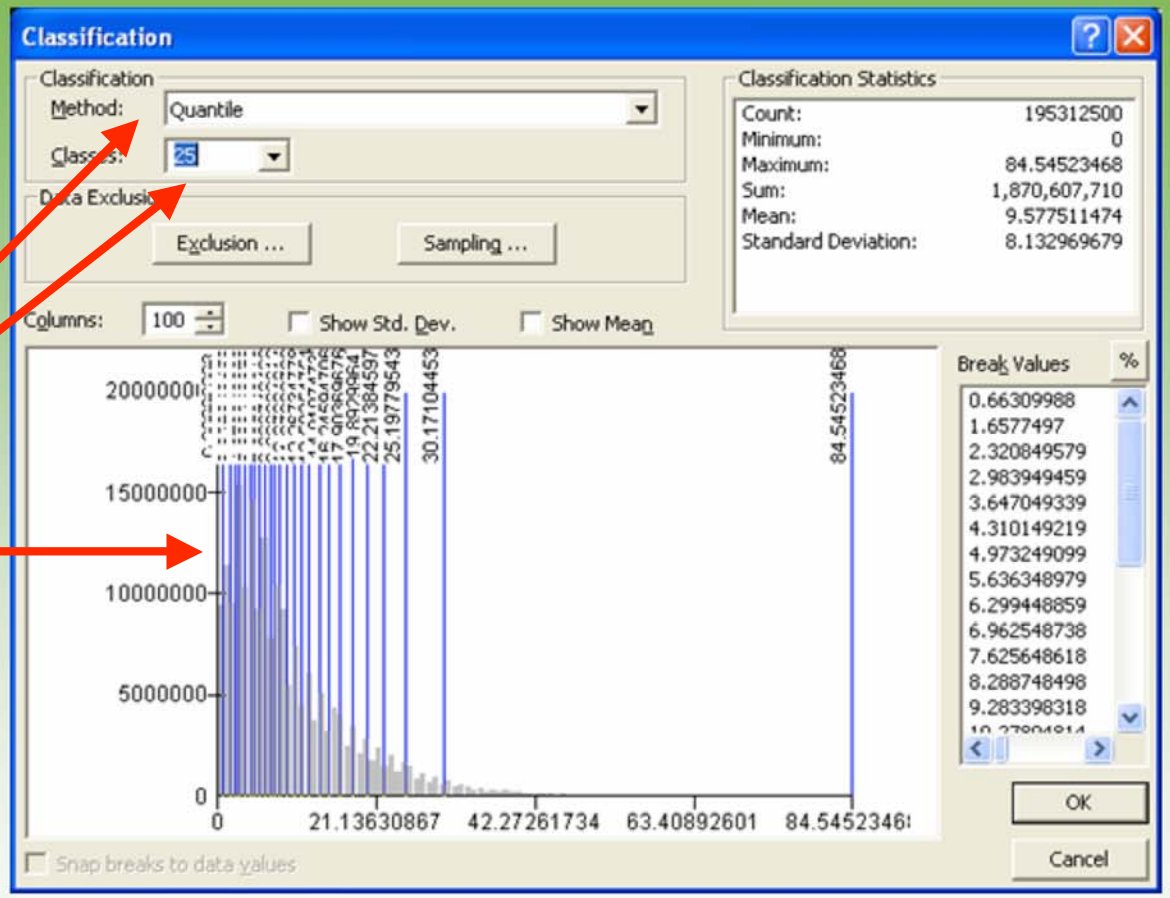
In areas of relatively low relief, Quantile puts more division breaks on the lower angles



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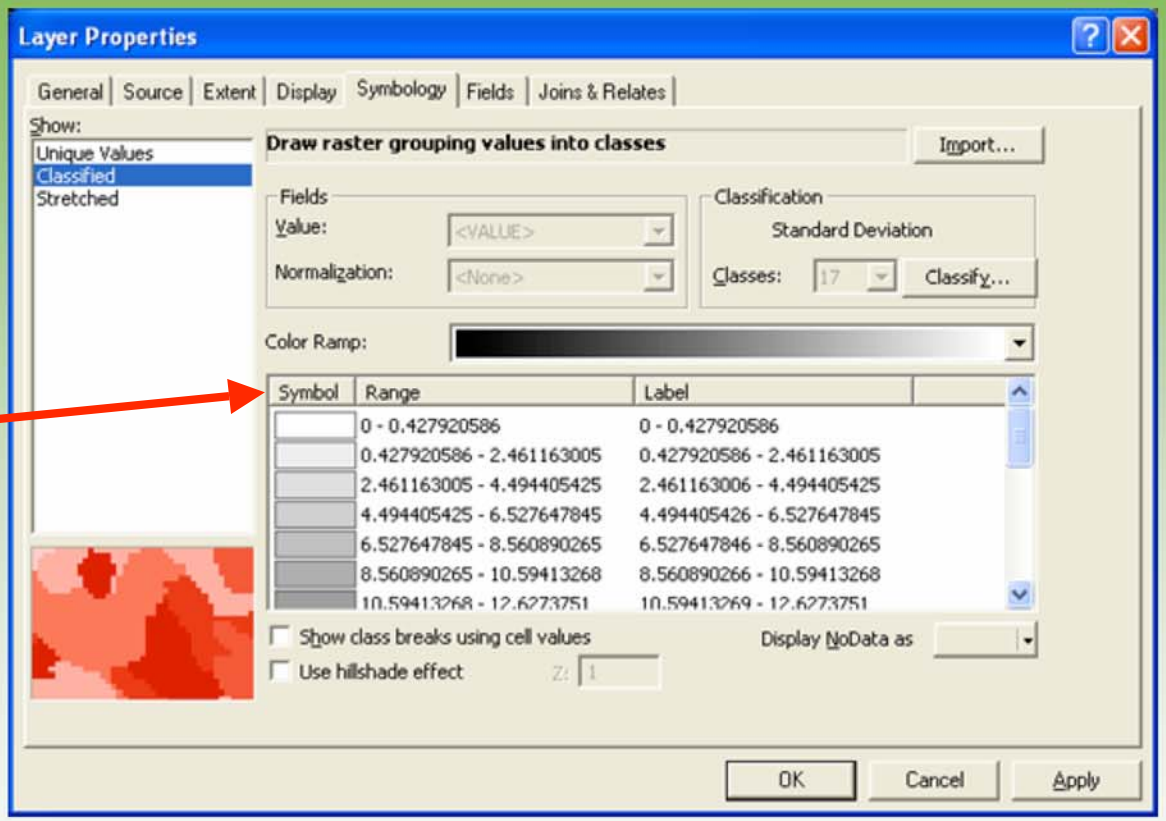
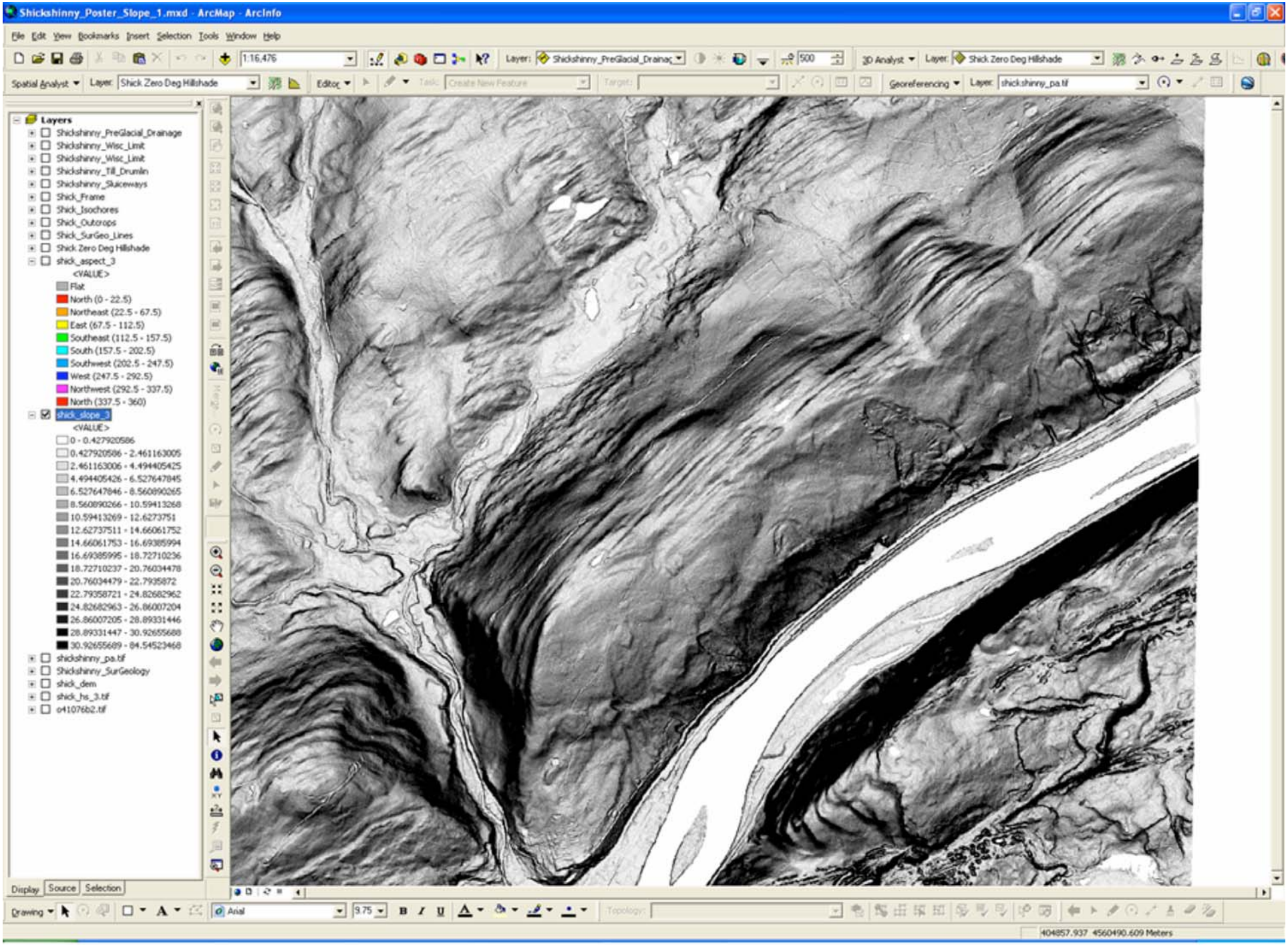
Go back to layer properties

If necessary, push the symbol button and invert the color ramp so white is flat and low angles progress in gray




Shickshinny_Poster_Slope_1.mxd - ArcMap - ArcInfo
File Edit View Bookmarks Insert Selection Tools Window Help
Layers
Shickshinny_PreGlacial_Drainage
Shickshinny_Wisc_Limit
Shickshinny_Wisc_Limit
Shickshinny_Till_Drumlin
Shickshinny_Skiaceways
Shick_Frame
Shick_Isochores
Shick_Outcrops
Shick_SurGeo_Lines
Shick Zero Deg Hillshade
shick_aspect_3
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Flat
North (0 - 22.5)
Northeast (22.5 - 67.5)
East (67.5 - 112.5)
Southeast (112.5 - 157.5)
South (157.5 - 202.5)
Southwest (202.5 - 247.5)
West (247.5 - 292.5)
Northwest (292.5 - 337.5)
North (337.5 - 360)
shick_slope_3
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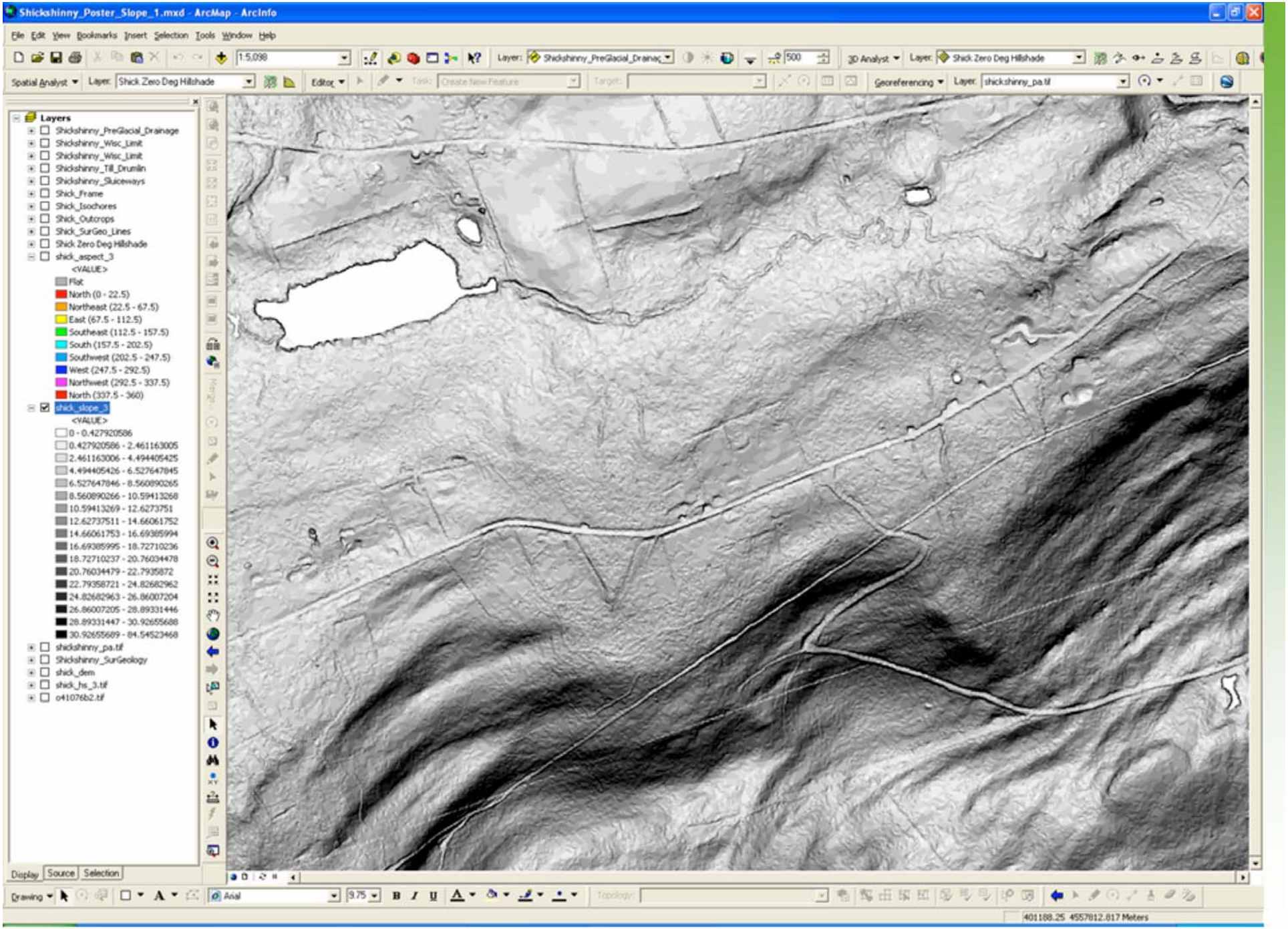
0.427920586 - 2.461163005
2.461163006 - 4.494405425
4.49405426 - 6.527647845
6.527647846 - 8.560890265
8.560890266 - 10.59413268
10.59413269 - 12.6273751
12.62737511 - 14.66061752
14.66061753 - 16.69385994
16.69385995 - 18.72710236
18.72710237 - 20.76034478
20.76034479 - 22.7935872
22.79358721 - 24.82682962
24.82682963 - 26.86007204
26.86007205 - 28.89331446
28.89331447 - 30.92655688
30.92655689 - 84.54523468
shickshinny_pa.tif
Shickshinny_SurGeology
shick_dem
shick_hs_3.tif
o41076b2.tif
Display Source Selection
Drawing
Arial
404857.937 4560490.609 Meters


Shickshinny_Poster_Slope_1.mxd - ArcMap - ArcInfo
File Edit View Bookmarks Insert Selection Tools Window Help
Layers
Shickshinny_PreGlacial_Drainage
Shickshinny_Wisc_Limit
Shickshinny_Wisc_Limit
Shickshinny_Till_Drumlin
Shickshinny_Sluceways
Shick_Frame
Shick_Isochores
Shick_Outcrops
Shick_SurGeo_Lines
Shick Zero Deg Hillshade
shick_aspect_3
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Flat
North (0 - 22.5)
Northeast (22.5 - 67.5)
East (67.5 - 112.5)
Southeast (112.5 - 157.5)
South (157.5 - 202.5)
Southwest (202.5 - 247.5)
West (247.5 - 292.5)
Northwest (292.5 - 337.5)
North (337.5 - 360)
shick_slope_3
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0.427920586 - 2.461163005
2.461163006 - 4.494405425
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6.527647846 - 8.560890265
8.560890266 - 10.59413268
10.59413269 - 12.6273751
12.62737511 - 14.66061752
14.66061753 - 16.69385994
16.69385995 - 18.72710236
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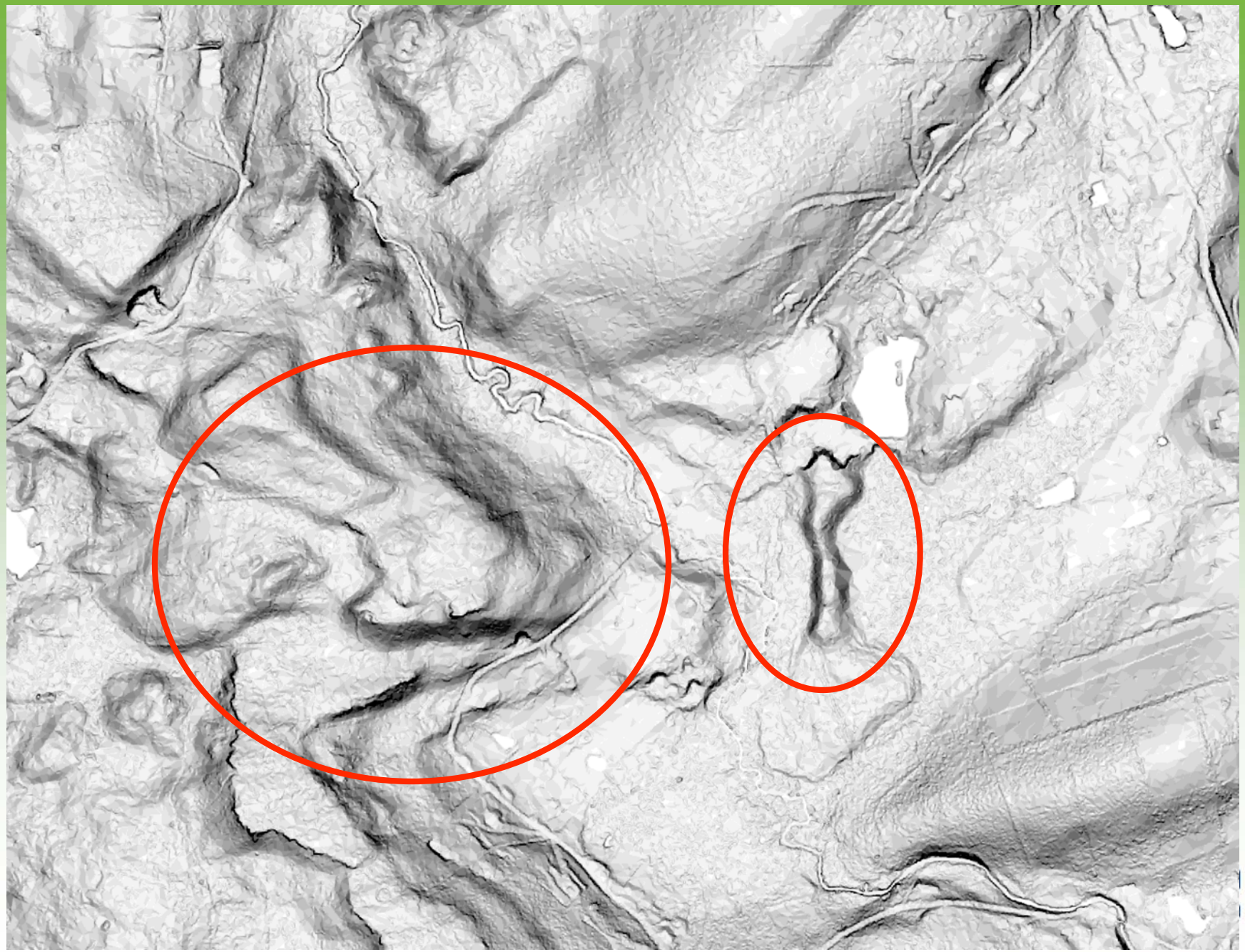
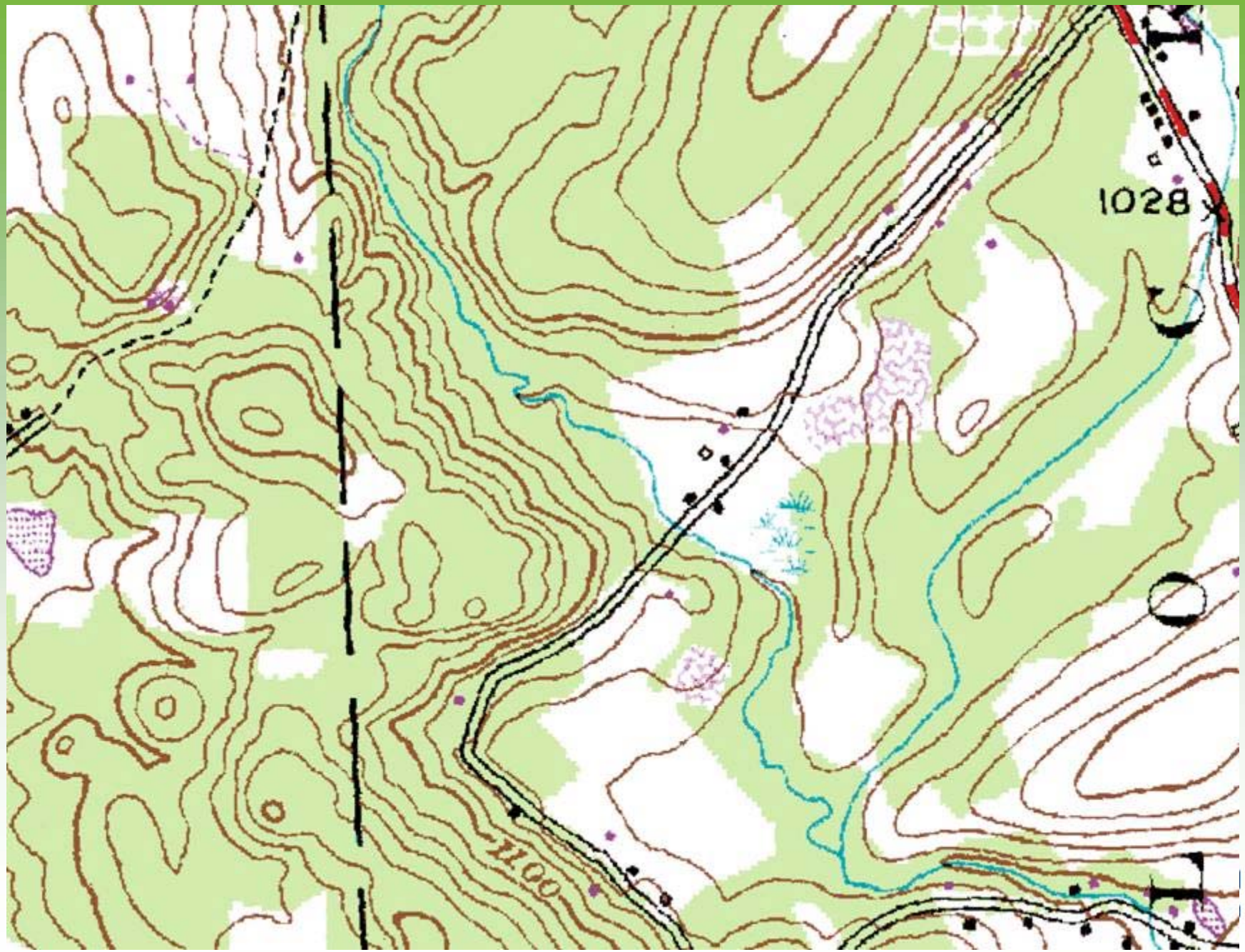
20.76034479 - 22.7935872
22.79358721 - 24.82682962
24.82682963 - 26.86007204
26.86007205 - 28.89331446
28.89331447 - 30.92655688
30.92655689 - 84.54523468
shickshinny_pa.tif
Shickshinny_SurGeology
shick_dem
shick_hs_3.tif
o41076b2.tif
Display Source Selection
401188.25 4557812.817 Meters

The caveat page…..

- We are looking strictly at slope angle
- We do not have “sun and shadow” effects
- We lose the sense of “up and down”
- Without visual clues – we cannot tell high points from low points

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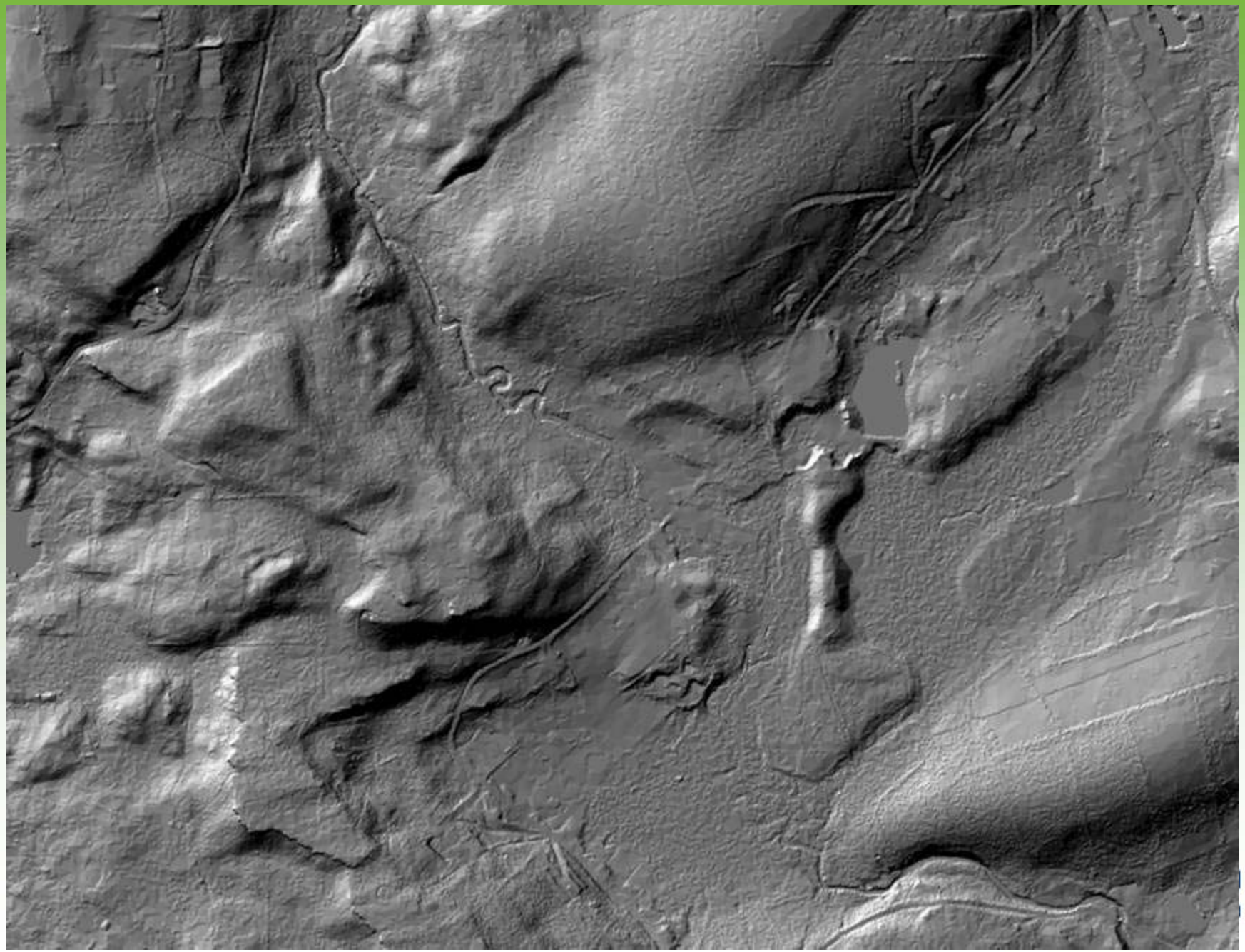
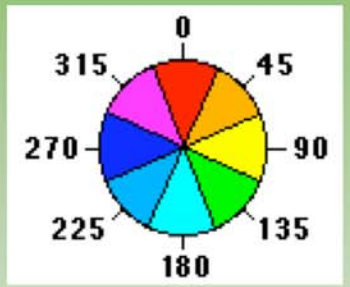
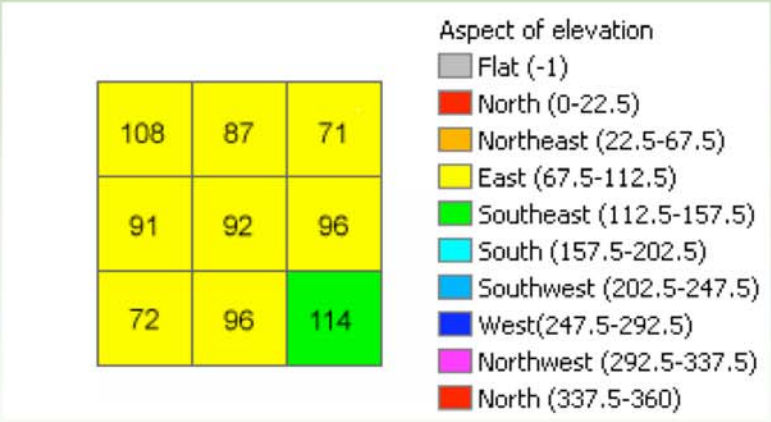
1100



Using Aspect for Slope Direction

- Aspect identifies the downslope direction of the maximum rate of change in value from each cell to its neighbors.
- Aspect can be thought of as the slope direction. The values of the output raster will be the compass direction of the aspect.
- Setting azimuth divisions to colors gives a visual indication of direction.





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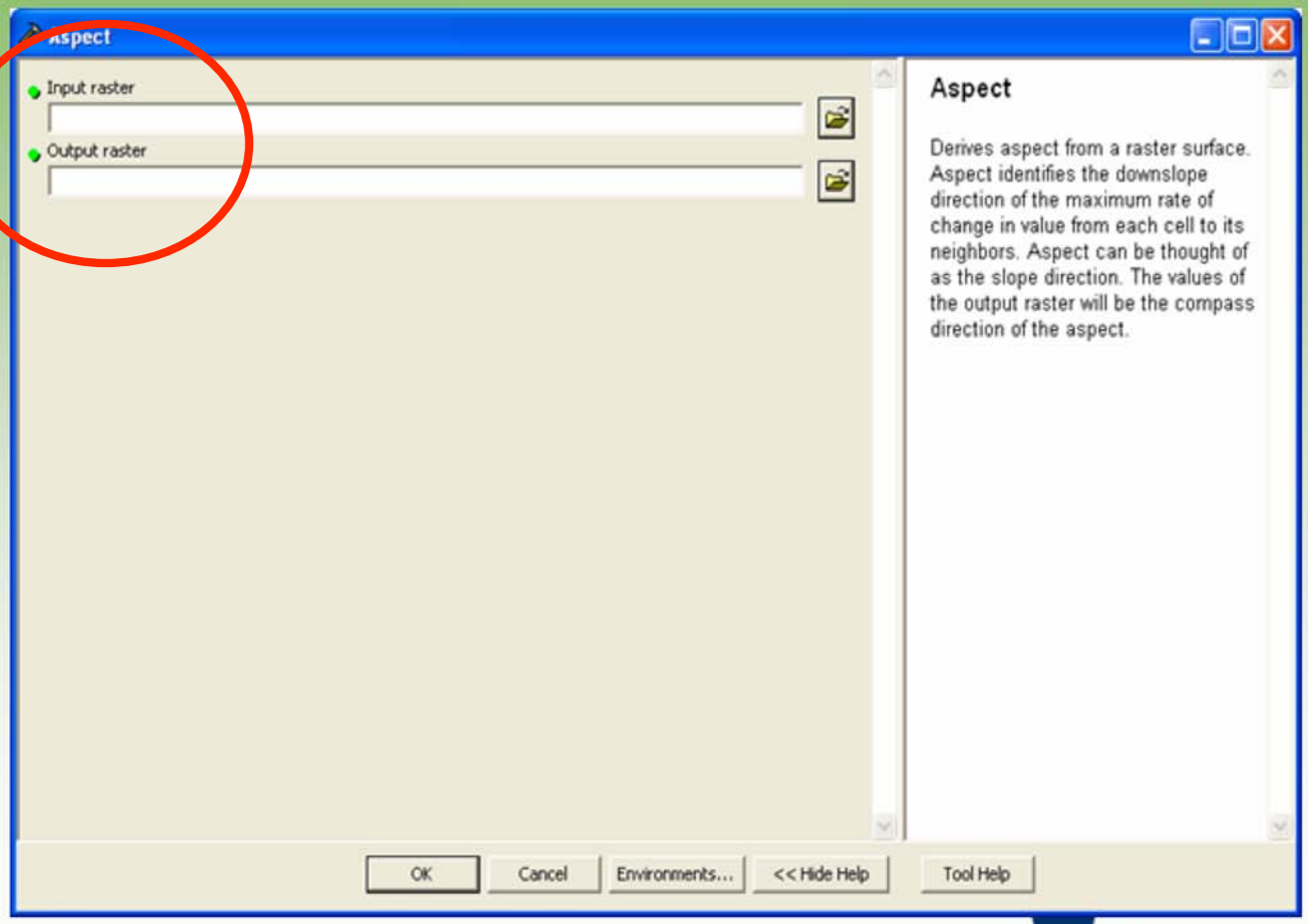
Creating an aspect grid



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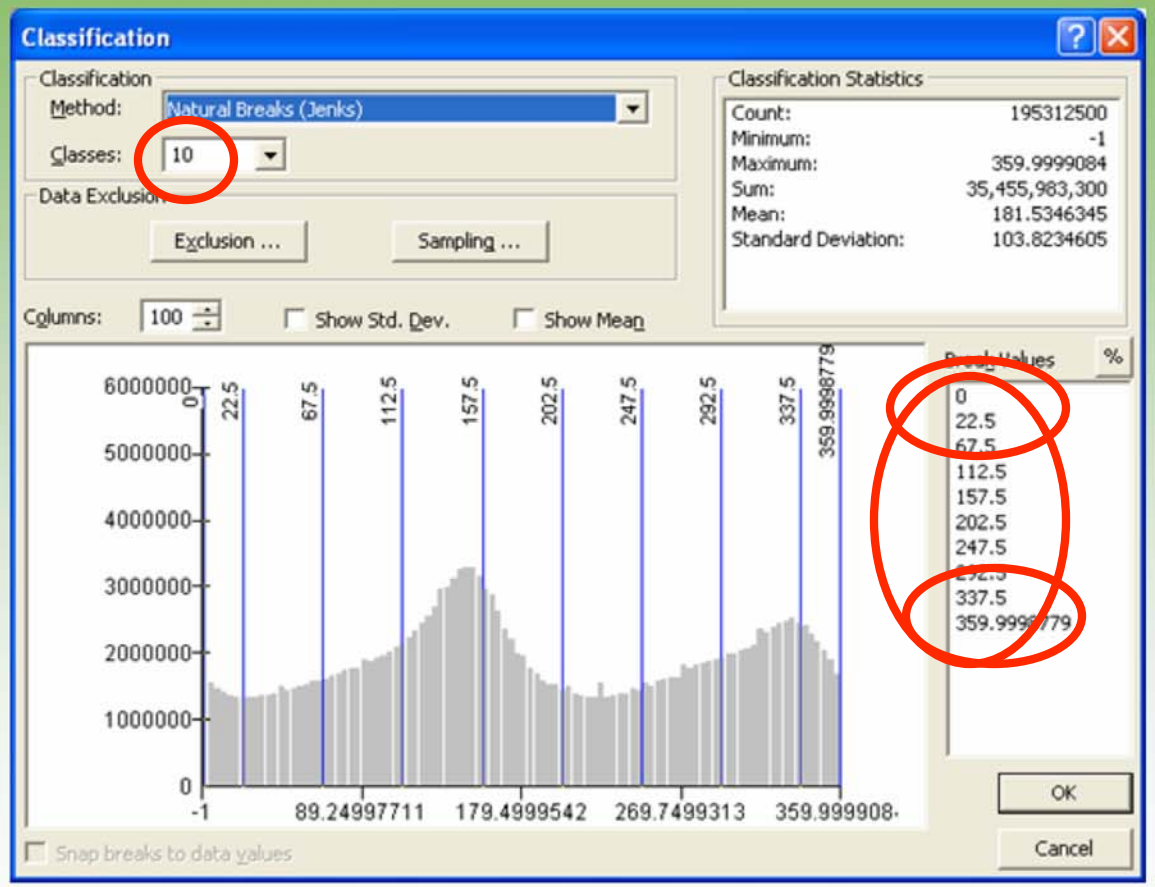
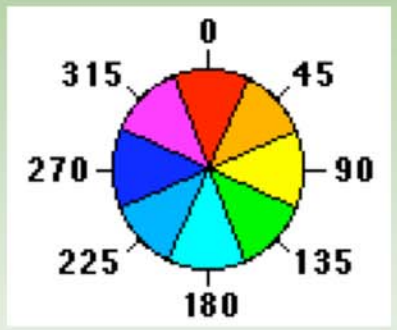
Setting azimuth break points





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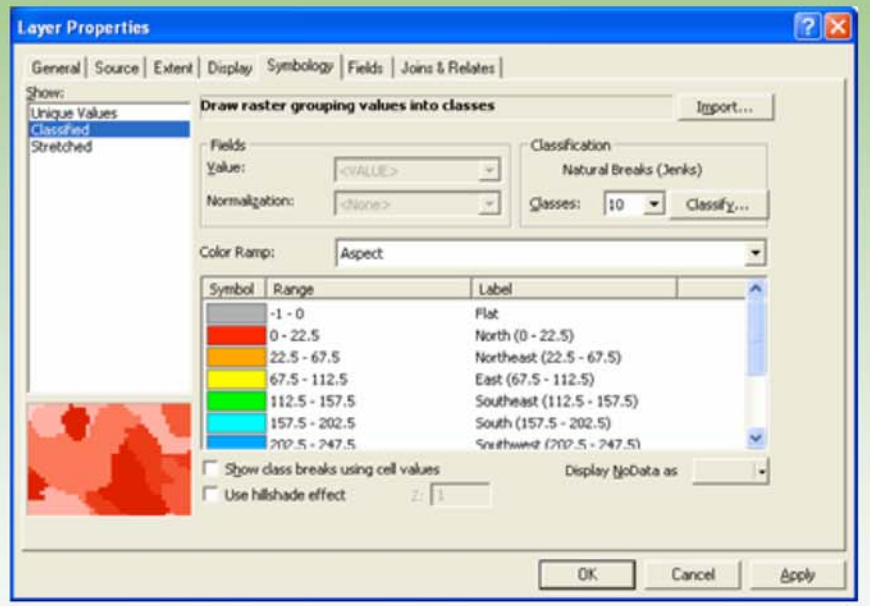
Color display settings

Break Settings at 45°

Break Range	Red	Green	Blue
North (0 - 22.5)	255	0	0
Northeast (22.5 – 67.5)	255	166	0
East (67.5 – 112.5)	255	255	0
Southeast (112.5 – 157.5)	0	255	0
South (157.5 – 202.5)	0	255	255
Southwest (202.5 – 247.5)	0	166	255
West (247.5 – 292.5)	0	0	255
Northwest (292.5 – 337.5)	0	550	255
North (337.5 – 359.9999)	255	0	0



Closing the North Point at 22.5° each

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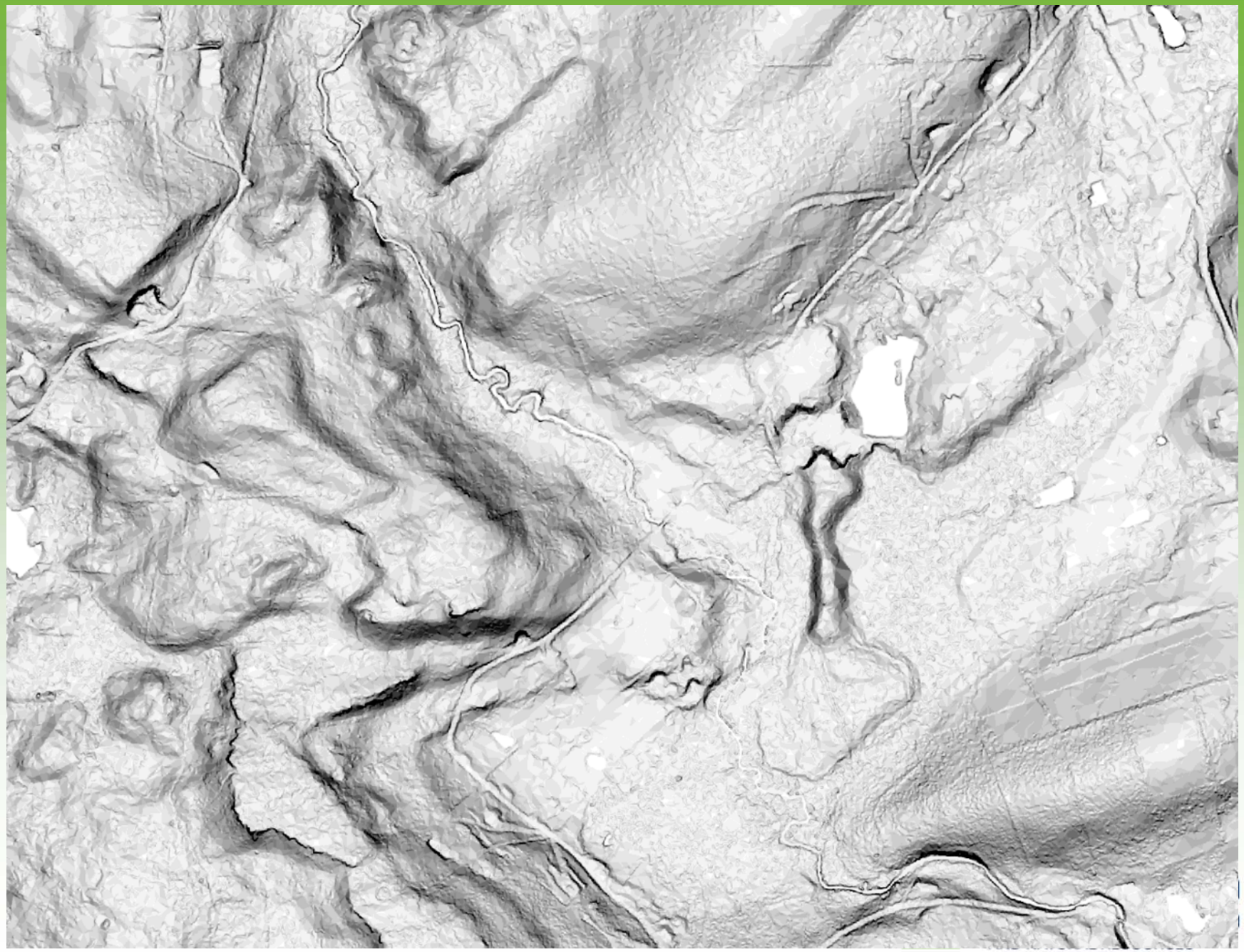
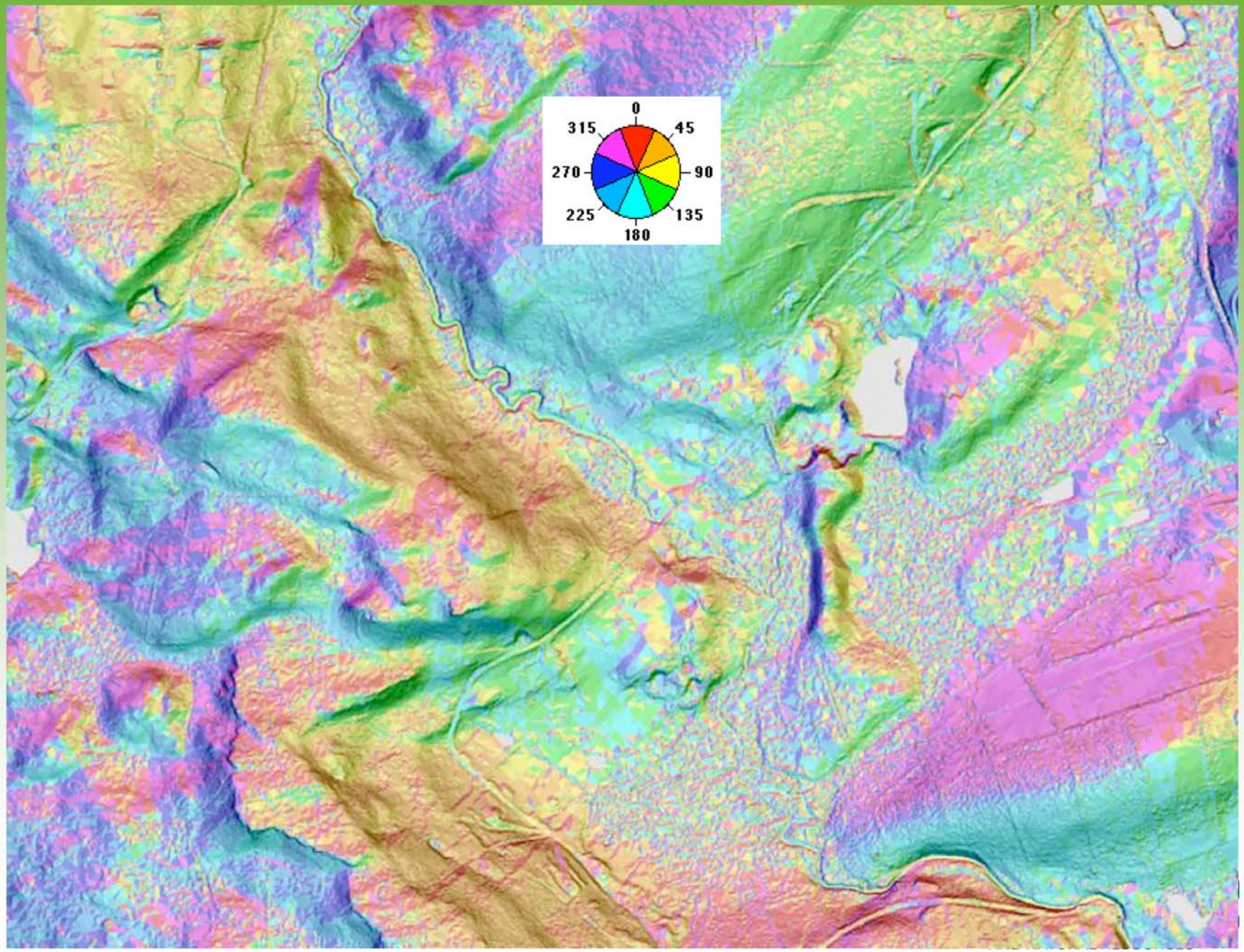
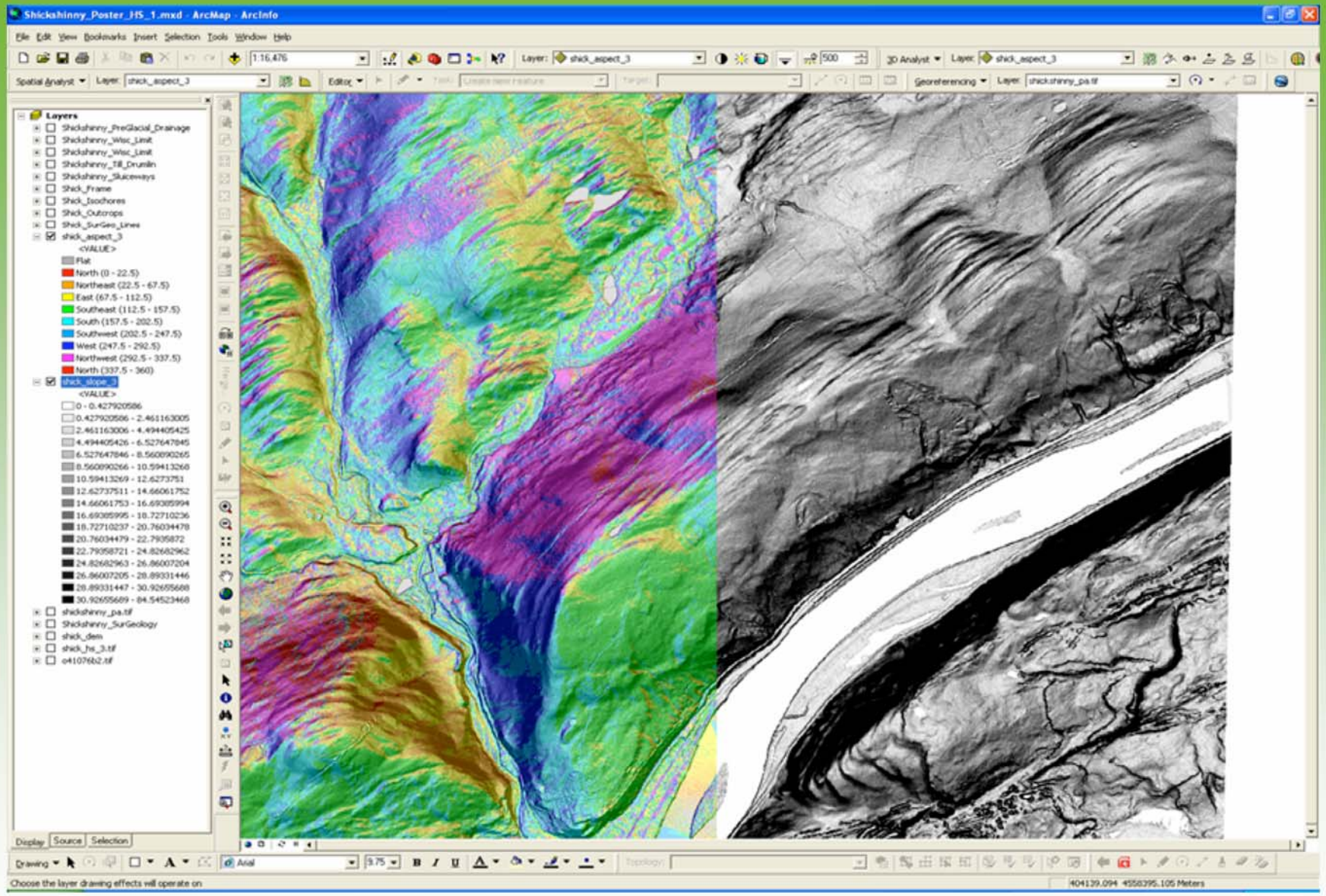



0
45
90
135
180
225
270
315

Aspect

- Can be displayed over a slope-shape
- Use transparency
- Use the “swipe tool”



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Examples

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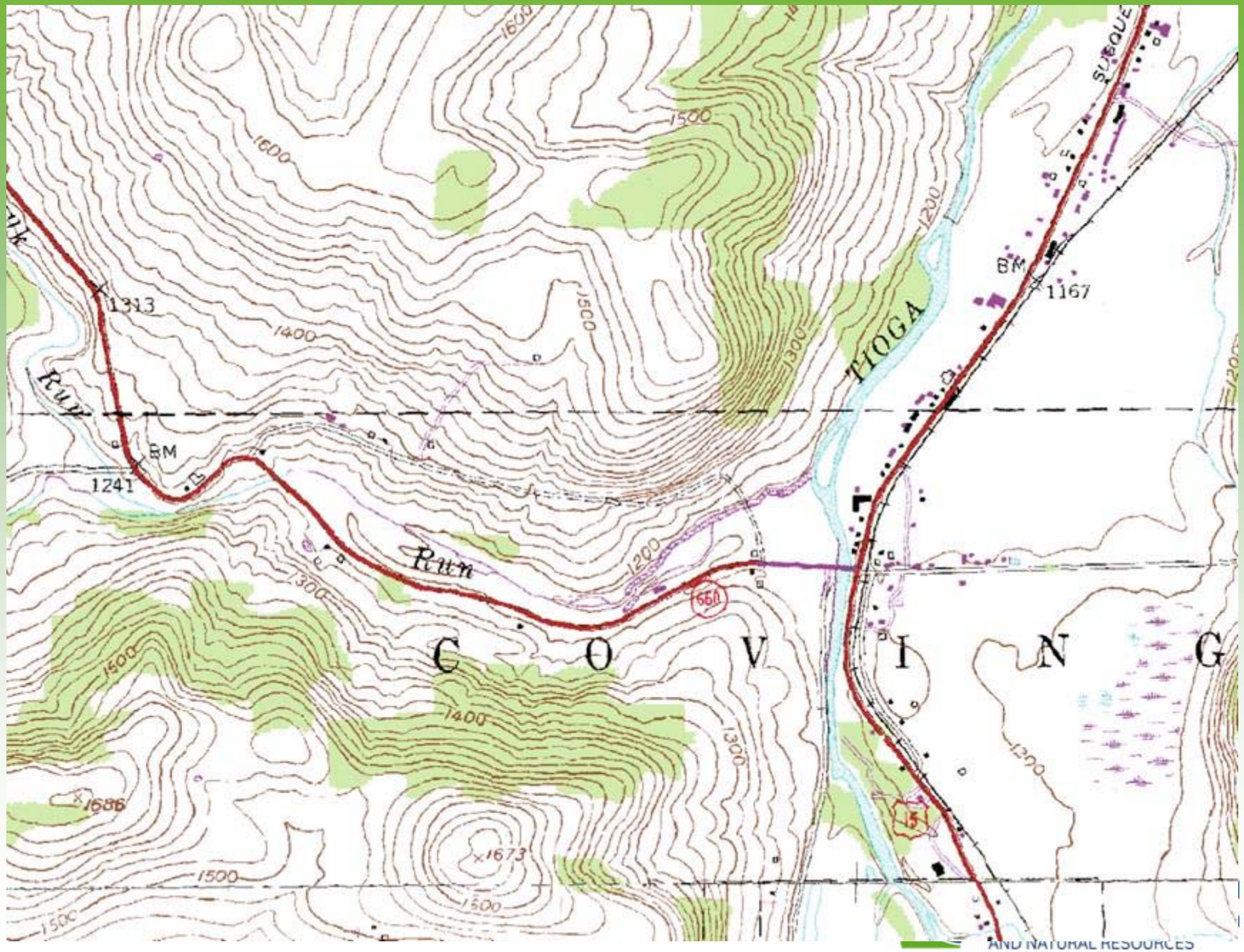
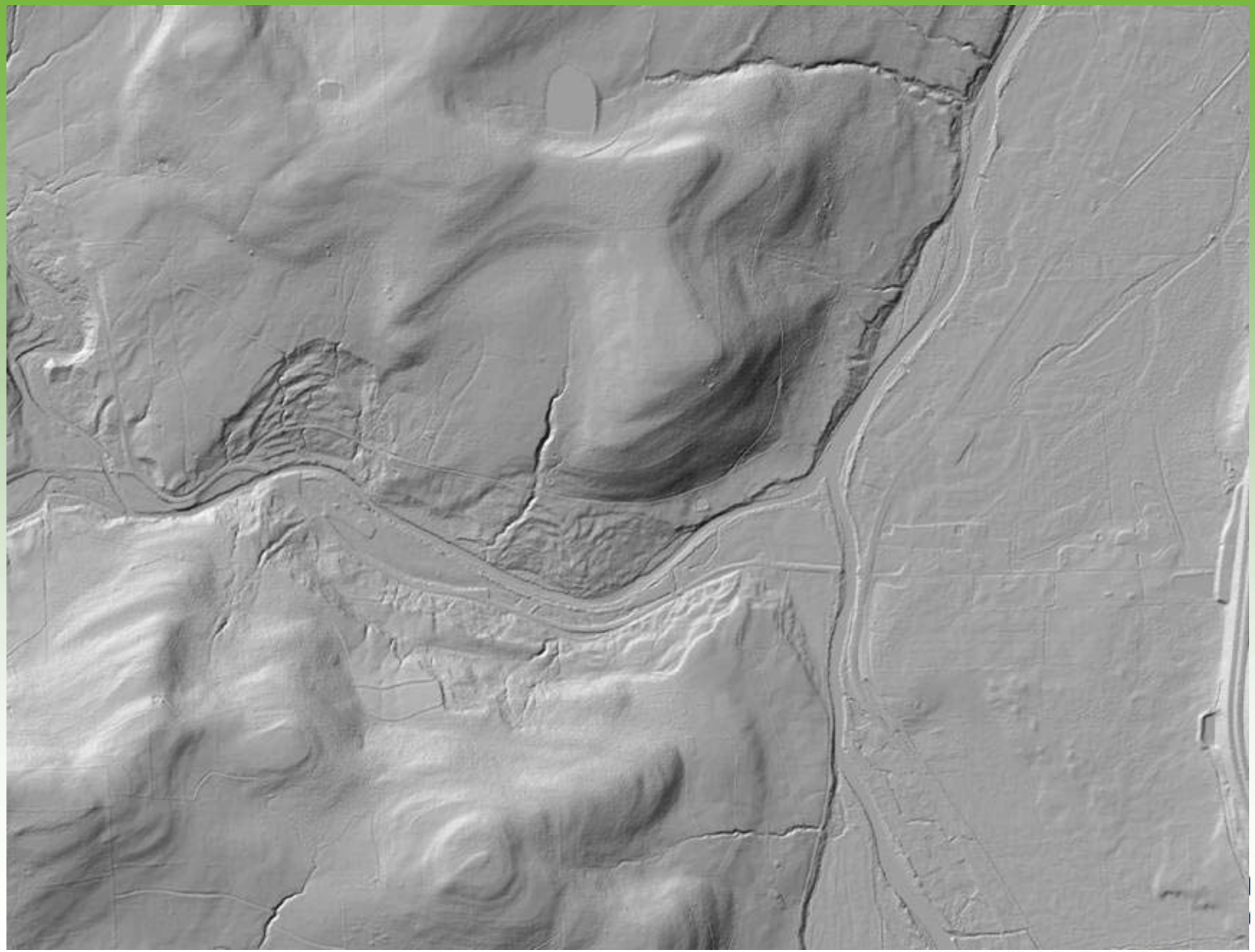
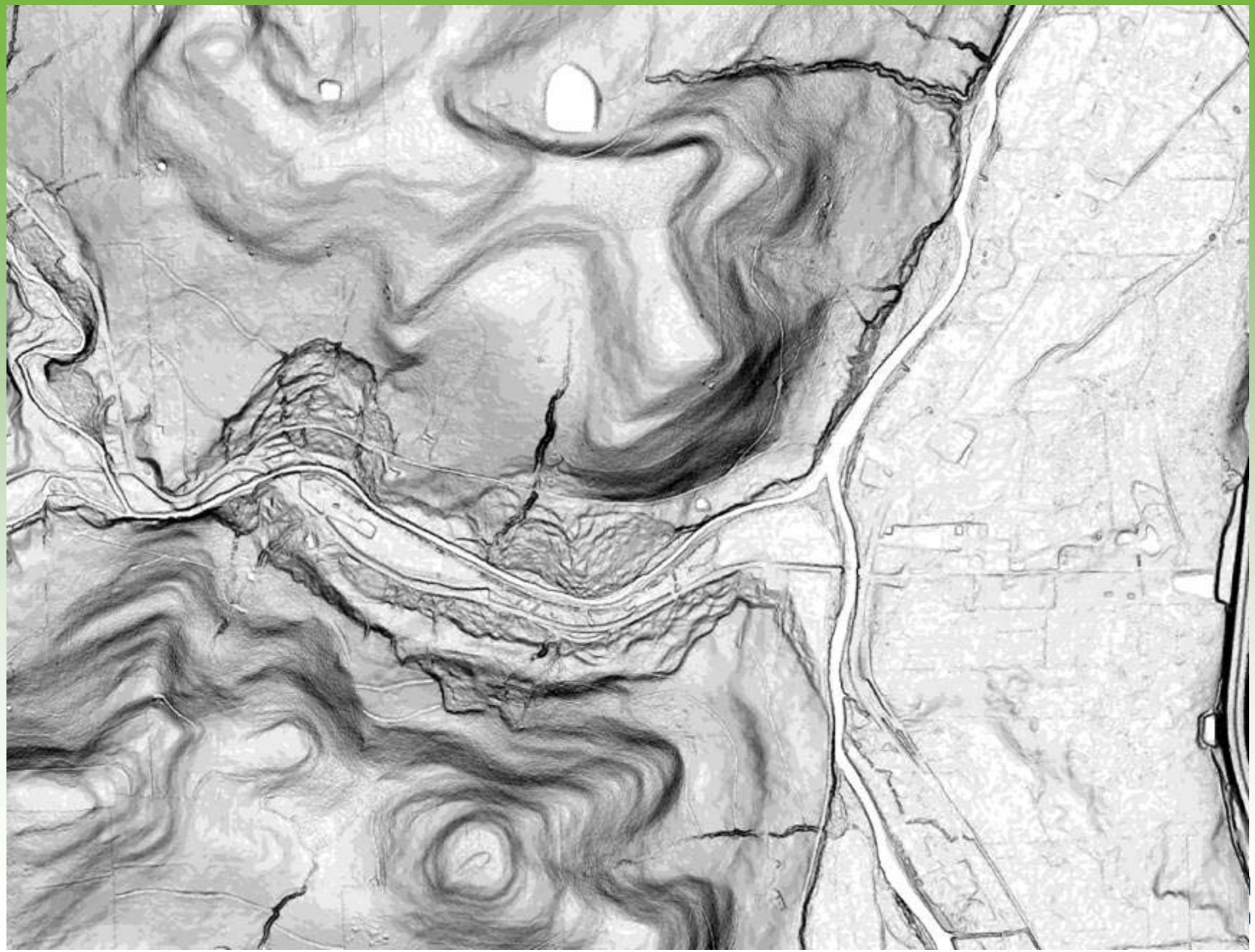
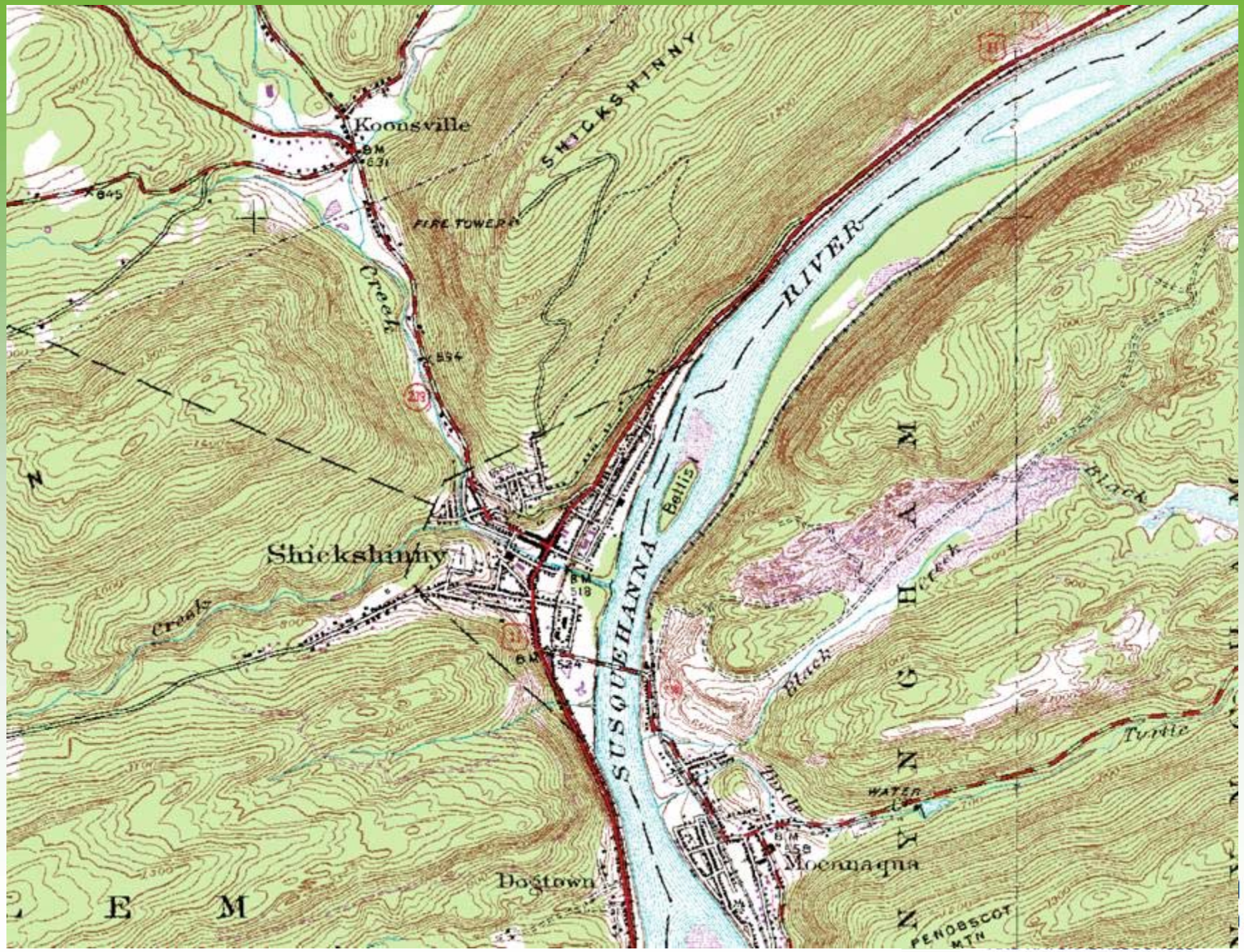
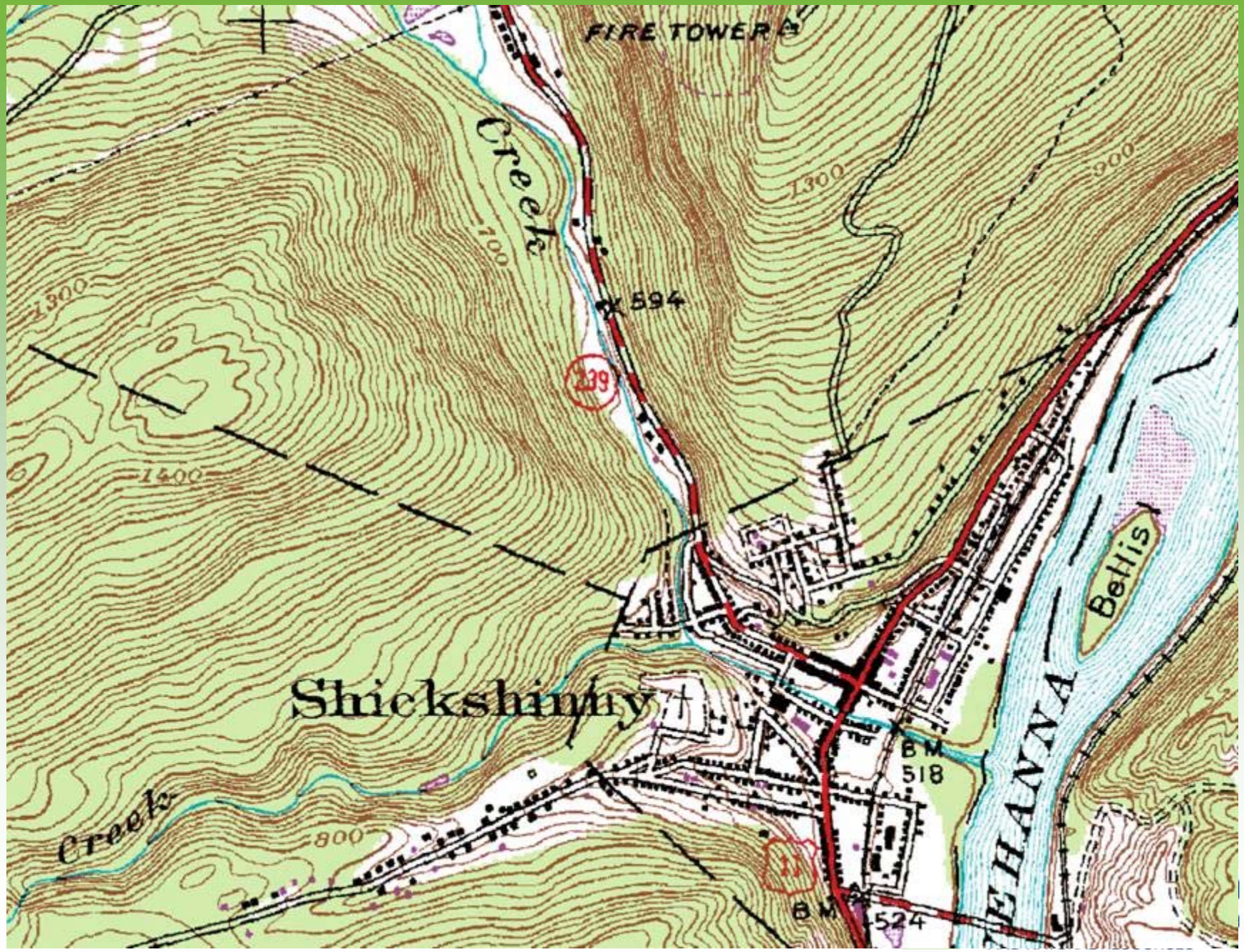

1313
Run
BM
1241
Run
1686
1673
C O V I N G
TIOGA
BM
1167
SUSQUE
1600
1500
1400
1300
1200
660
15
AND NATURAL RESOURCES

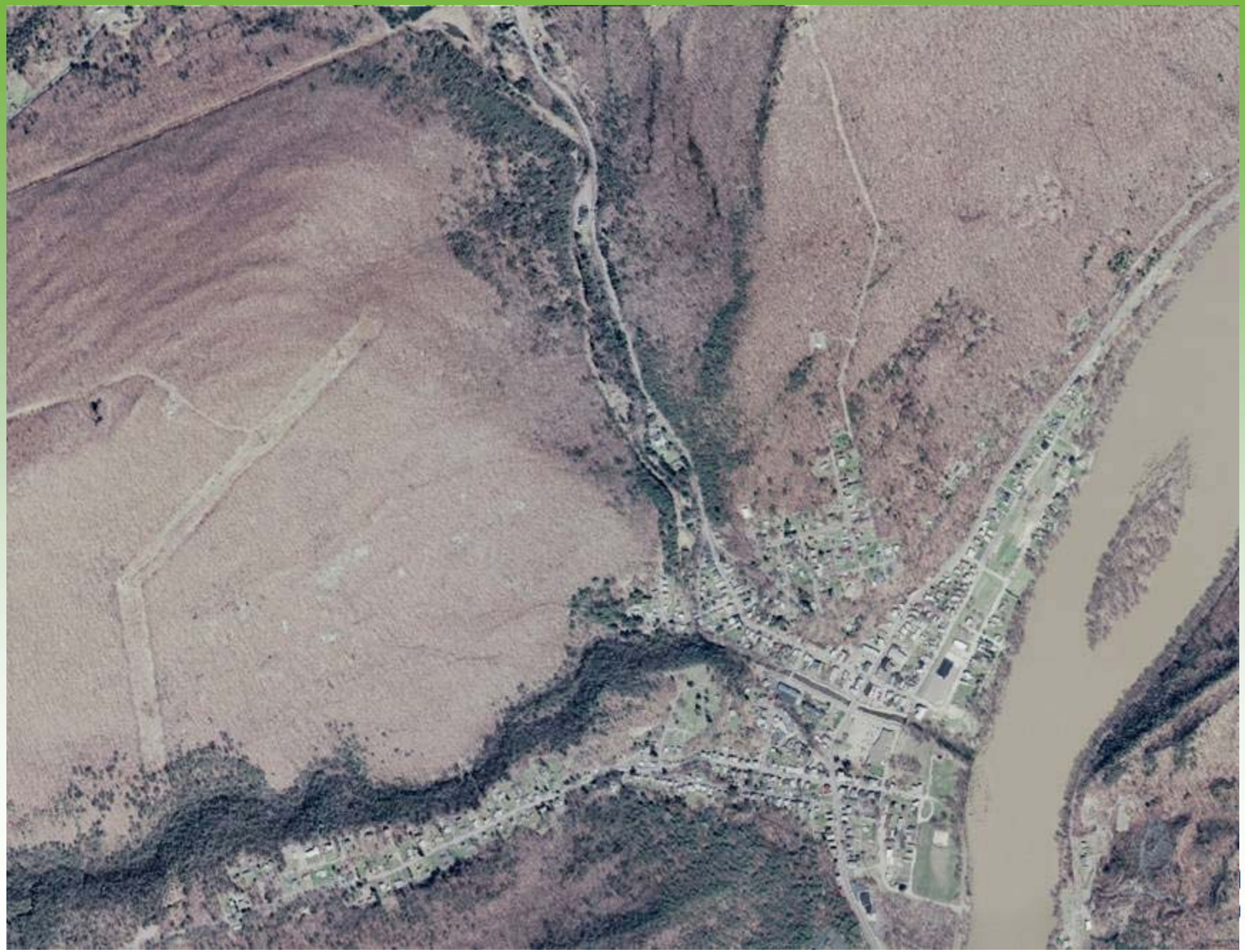
AND NATURAL RESOURCES

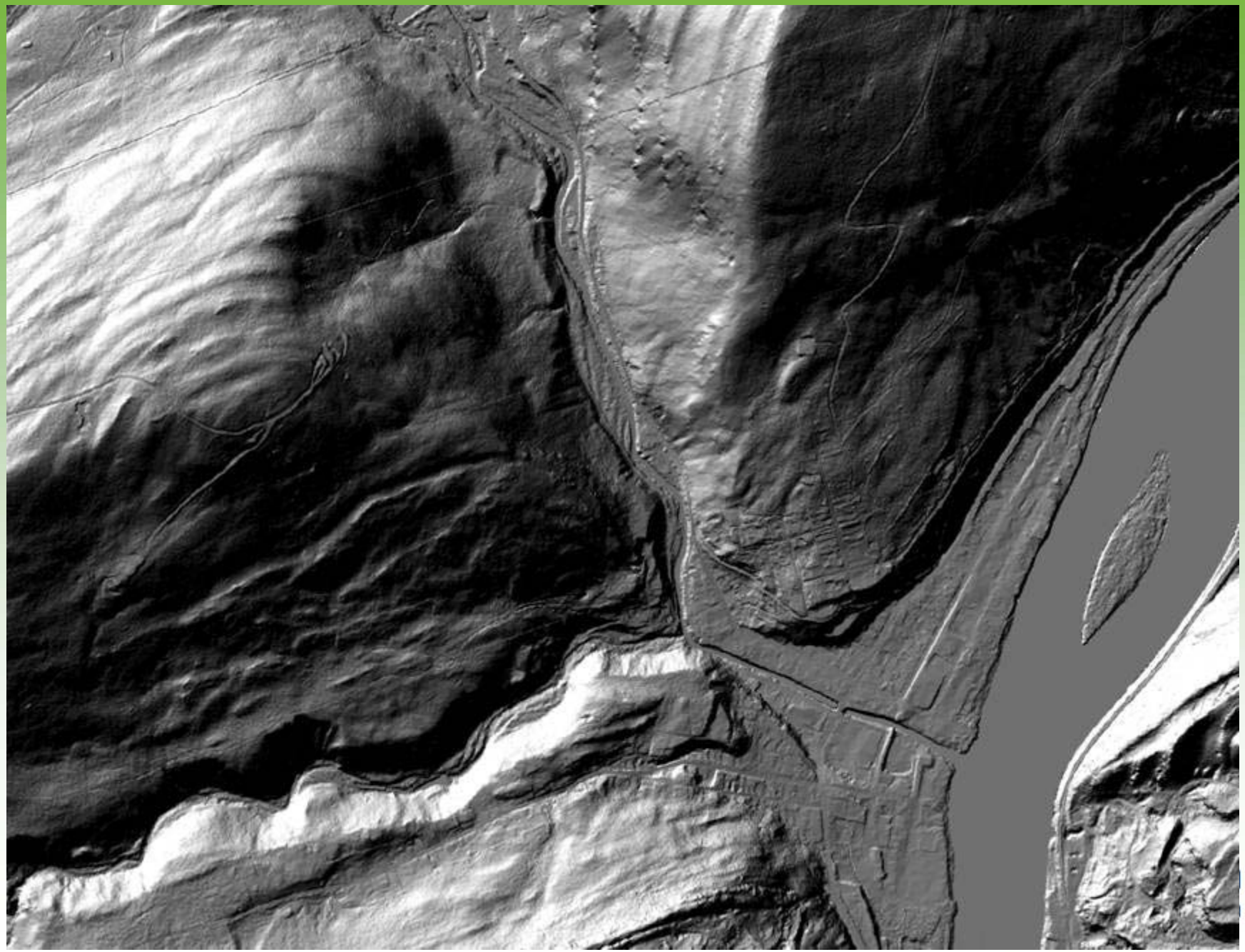


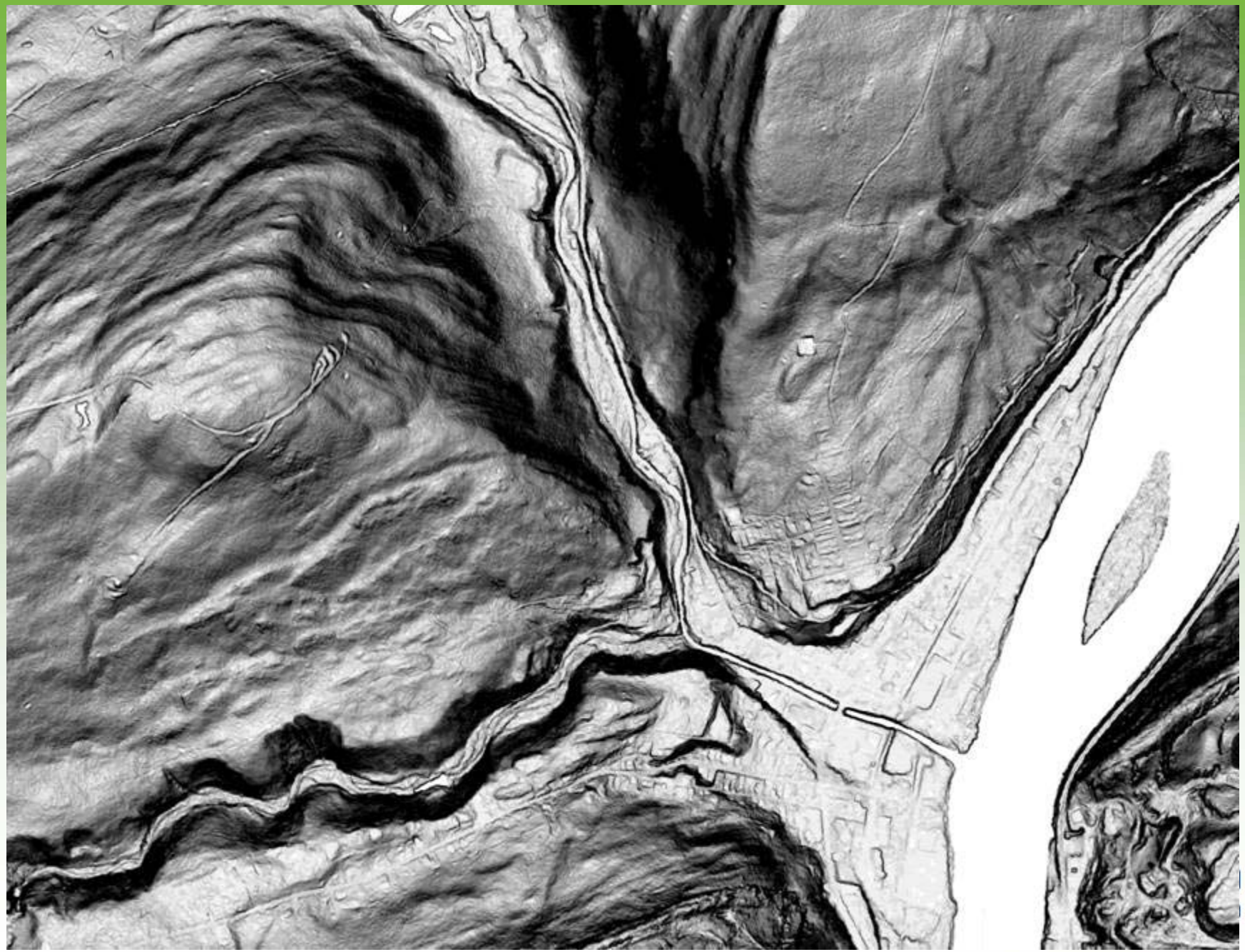


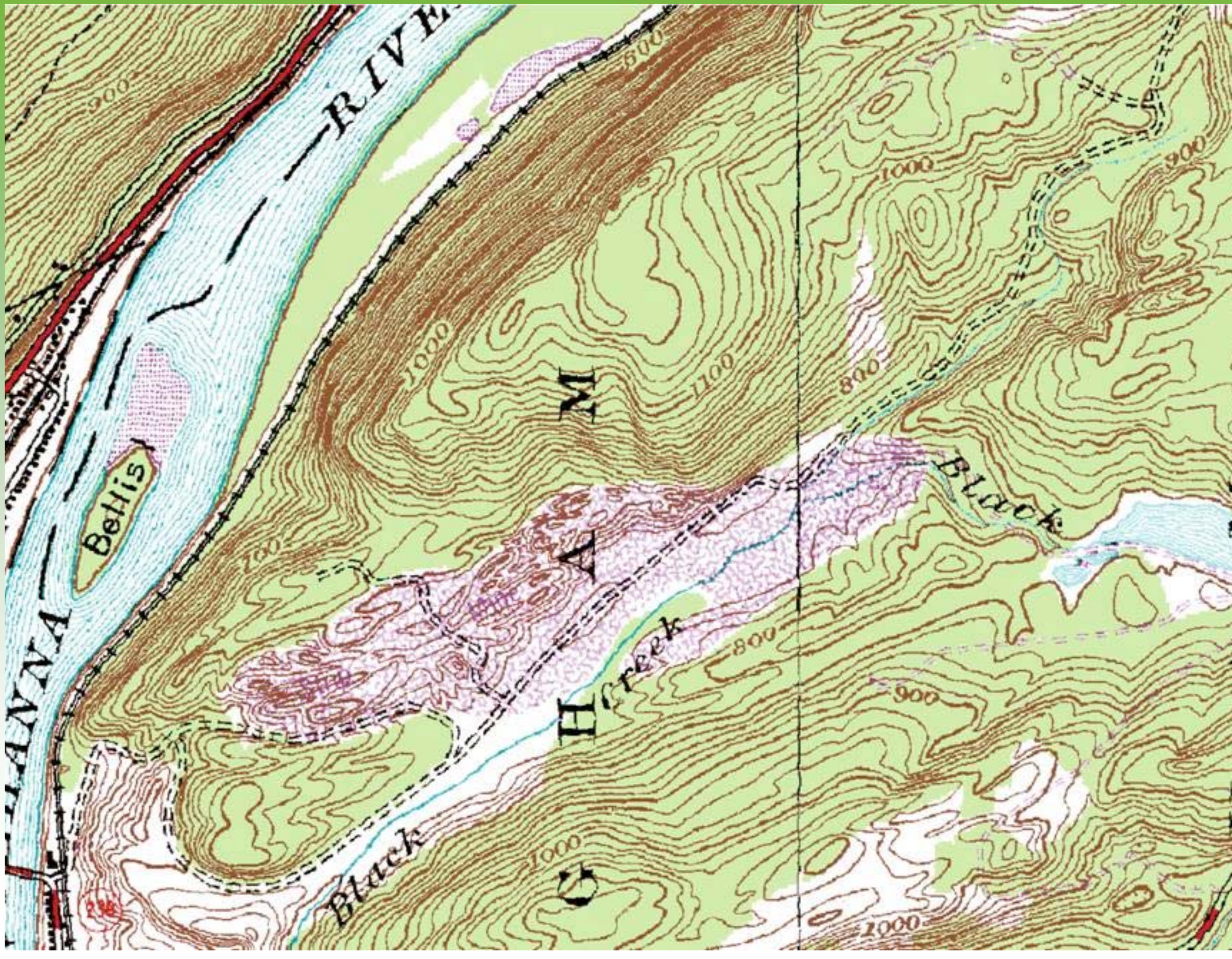

Koonsville
BM 631
845
FIRE TOWER
SHICKSHINNY
Creek
854
RIVER
SUSQUEHANNA
Ballis
Shickshinny
BM 518
Creek
BM
Black
Creek
Black
Creek
Turtle
WATER
Mocanaqua
Dogtown
PENOBSCOT MTN

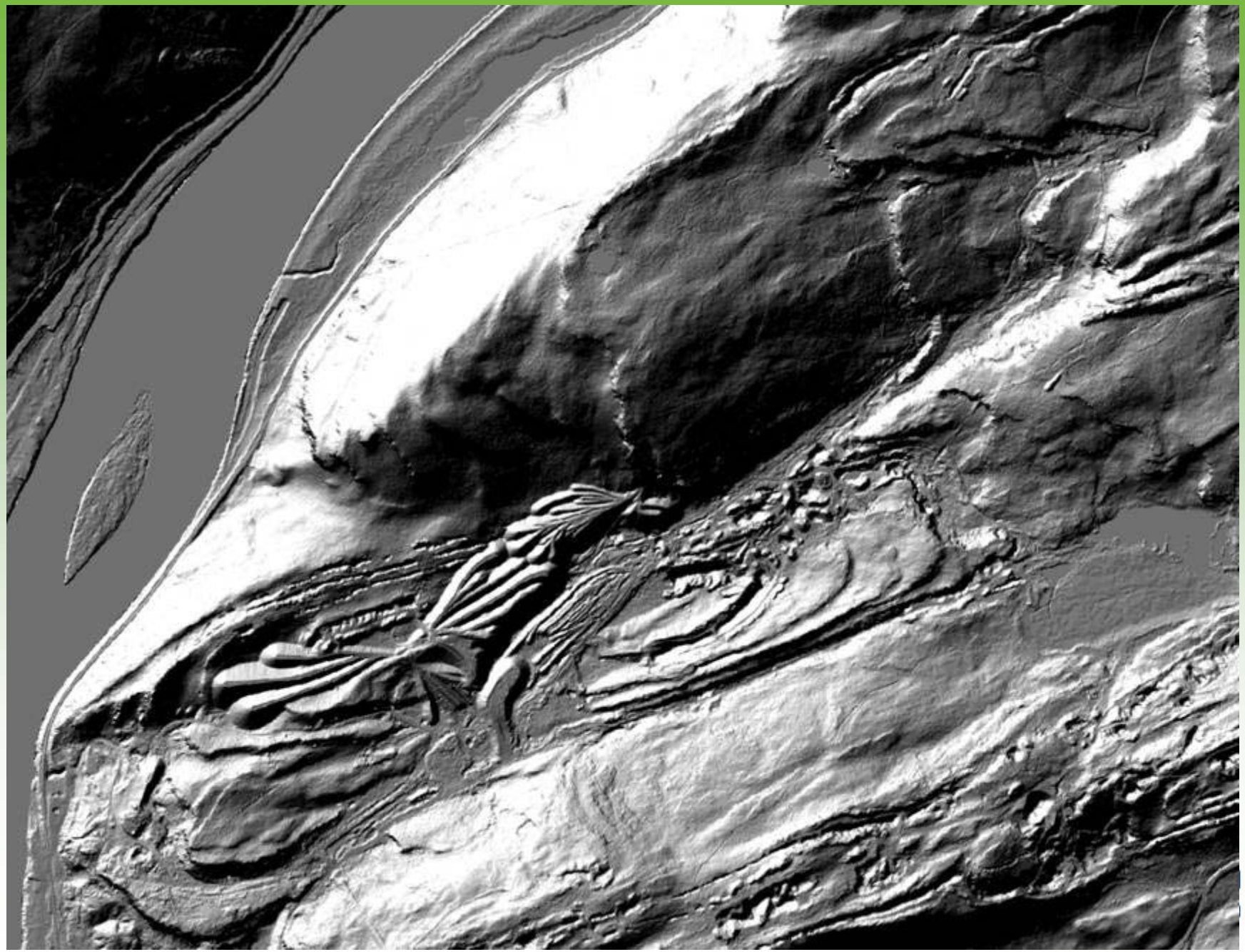

FIRE TOWER
Creek
1300
900
1300
700
1400
594
239
Shickshinny
BM
518
Creek
800
BM
524
SUSQUEHANNA
Bellis

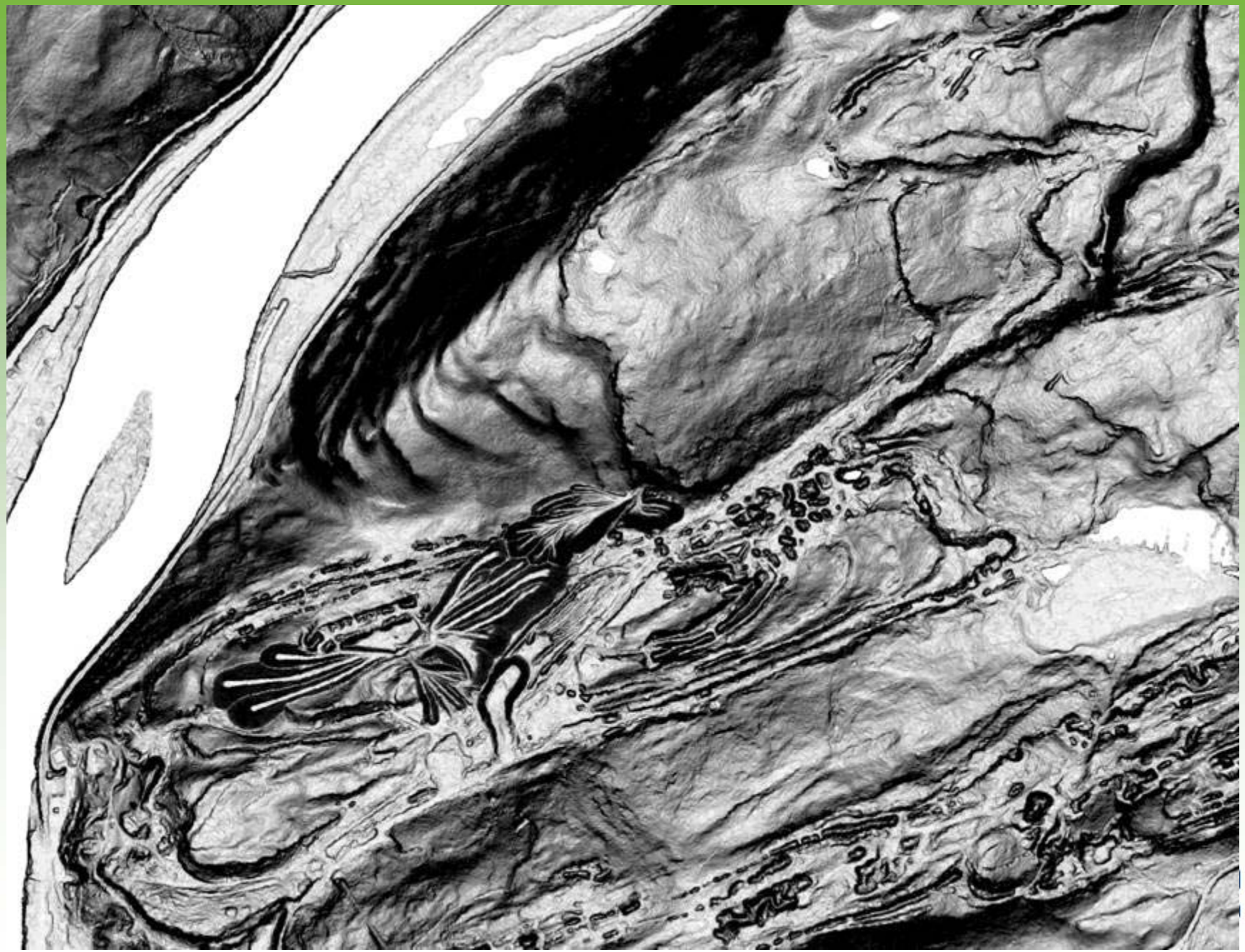


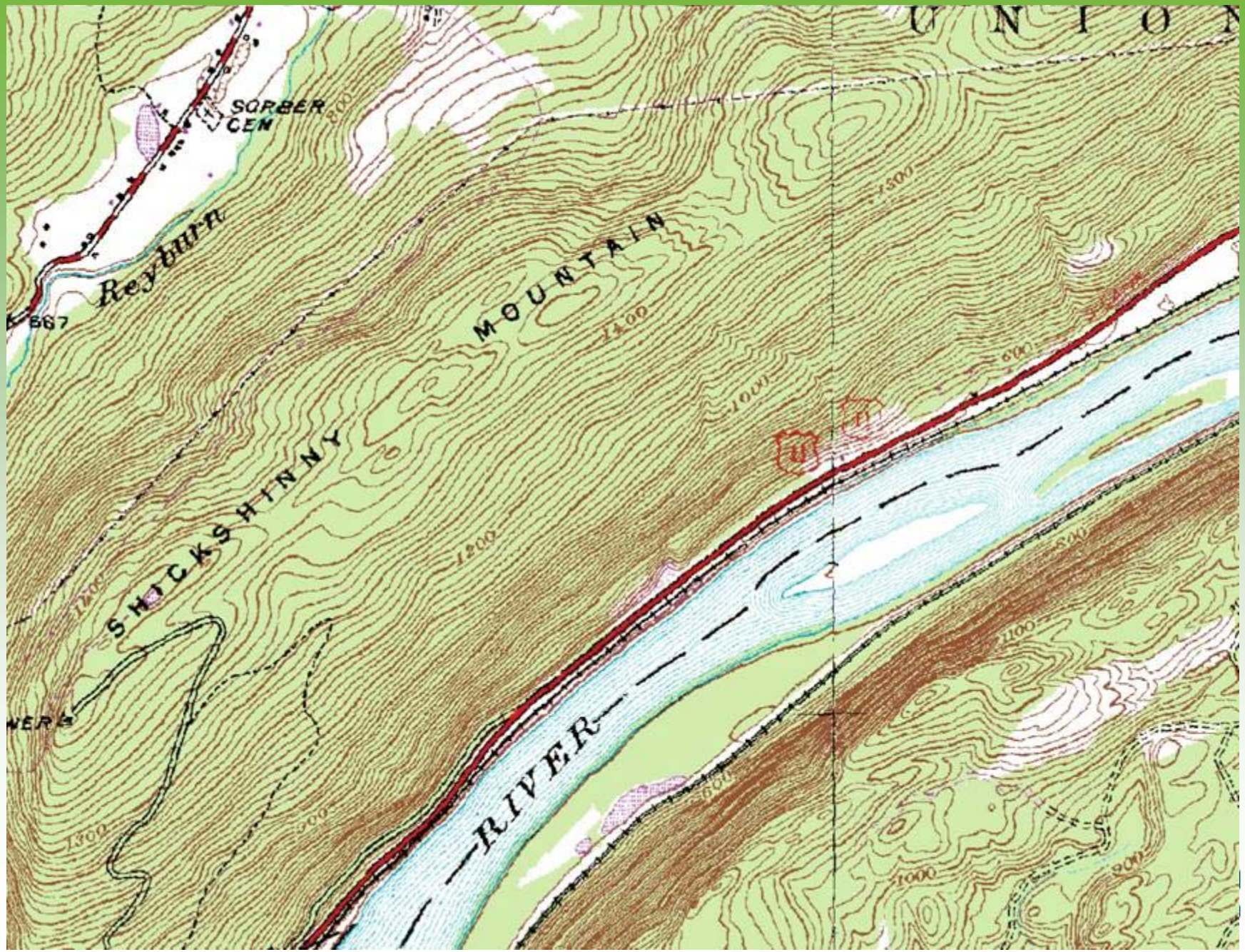


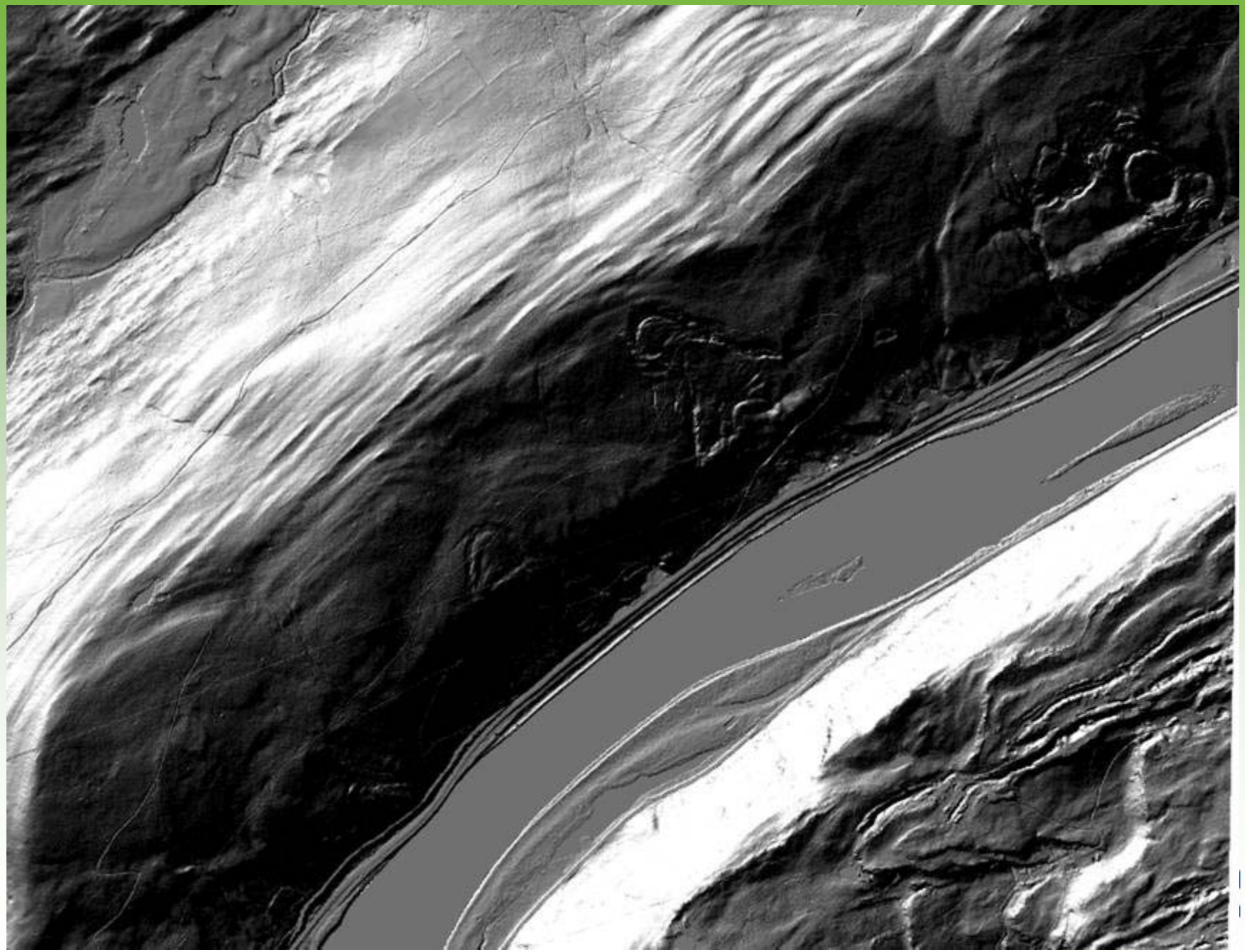


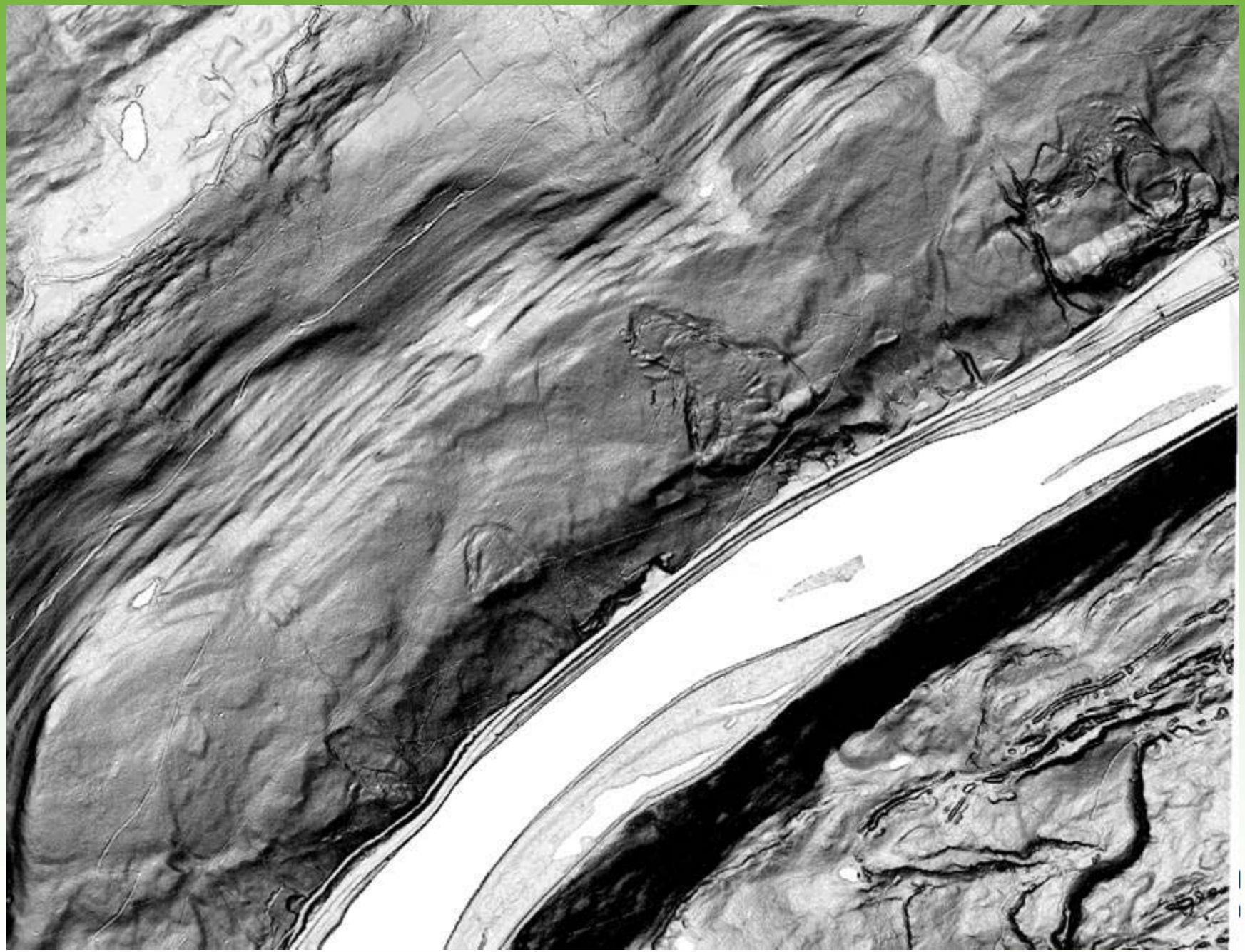

RIVE
ANNA
Bellis
M
A
H
G
Black
Creek
Black
Black
900
1000
1100
1000
800
700
800
900
1000
900
1000

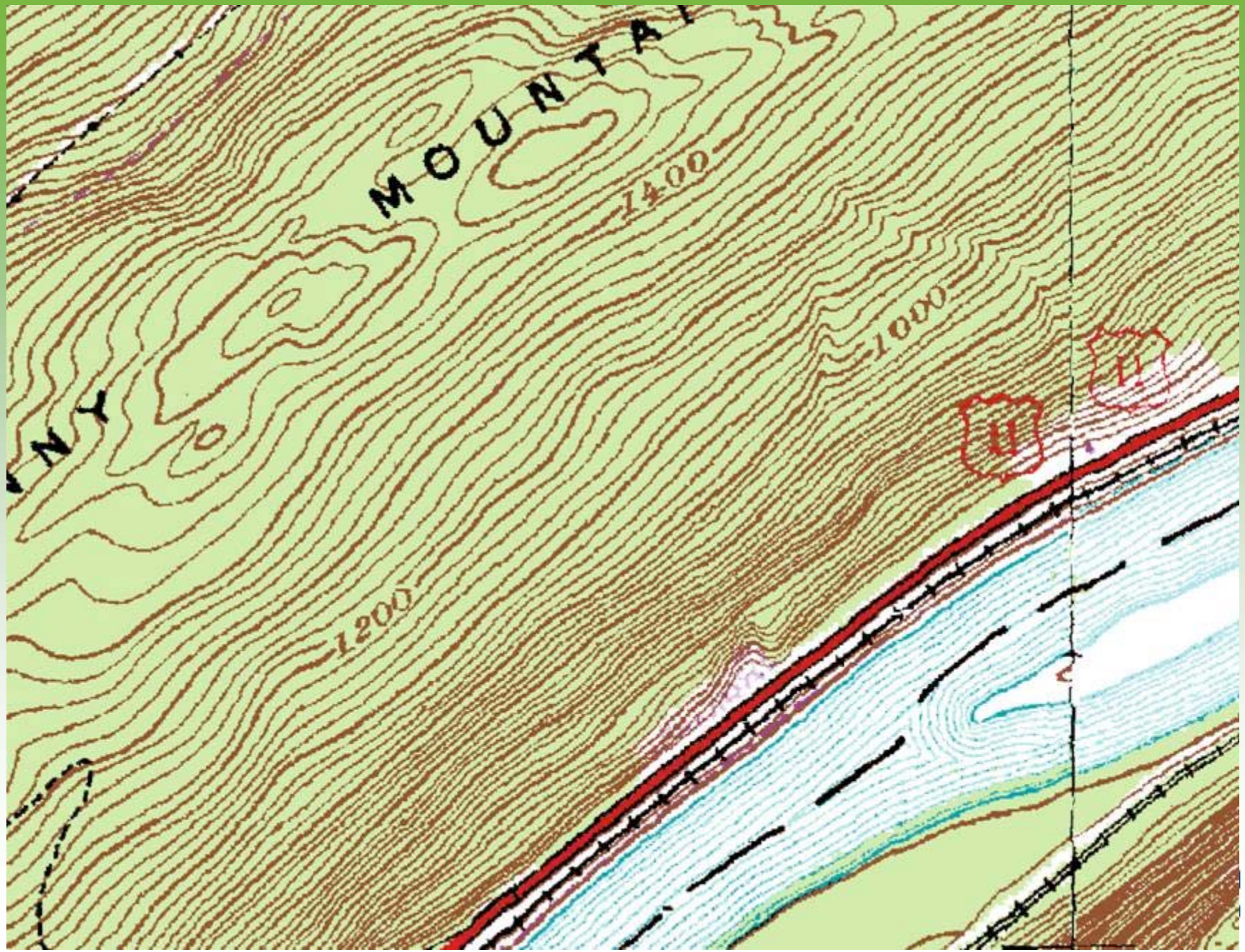


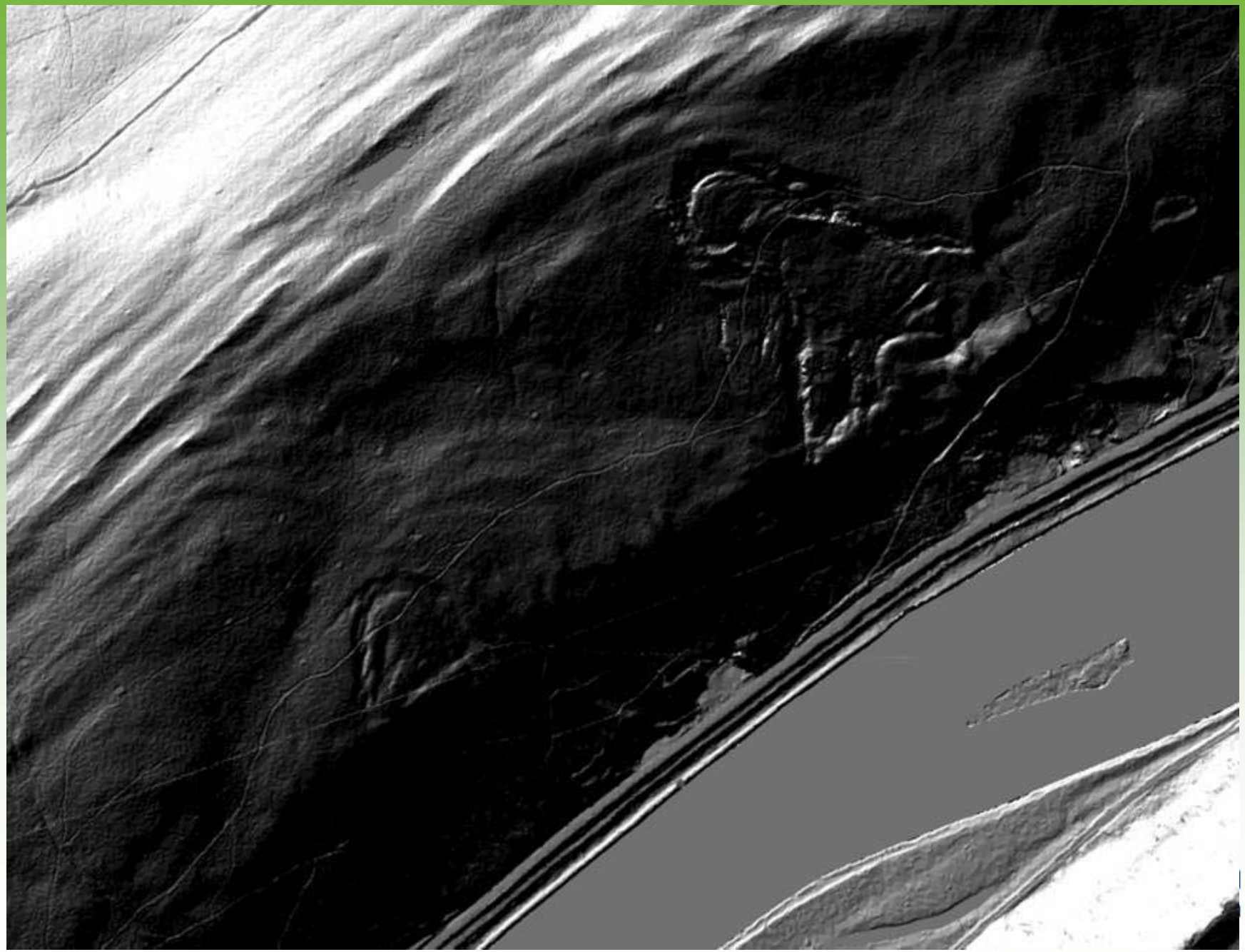


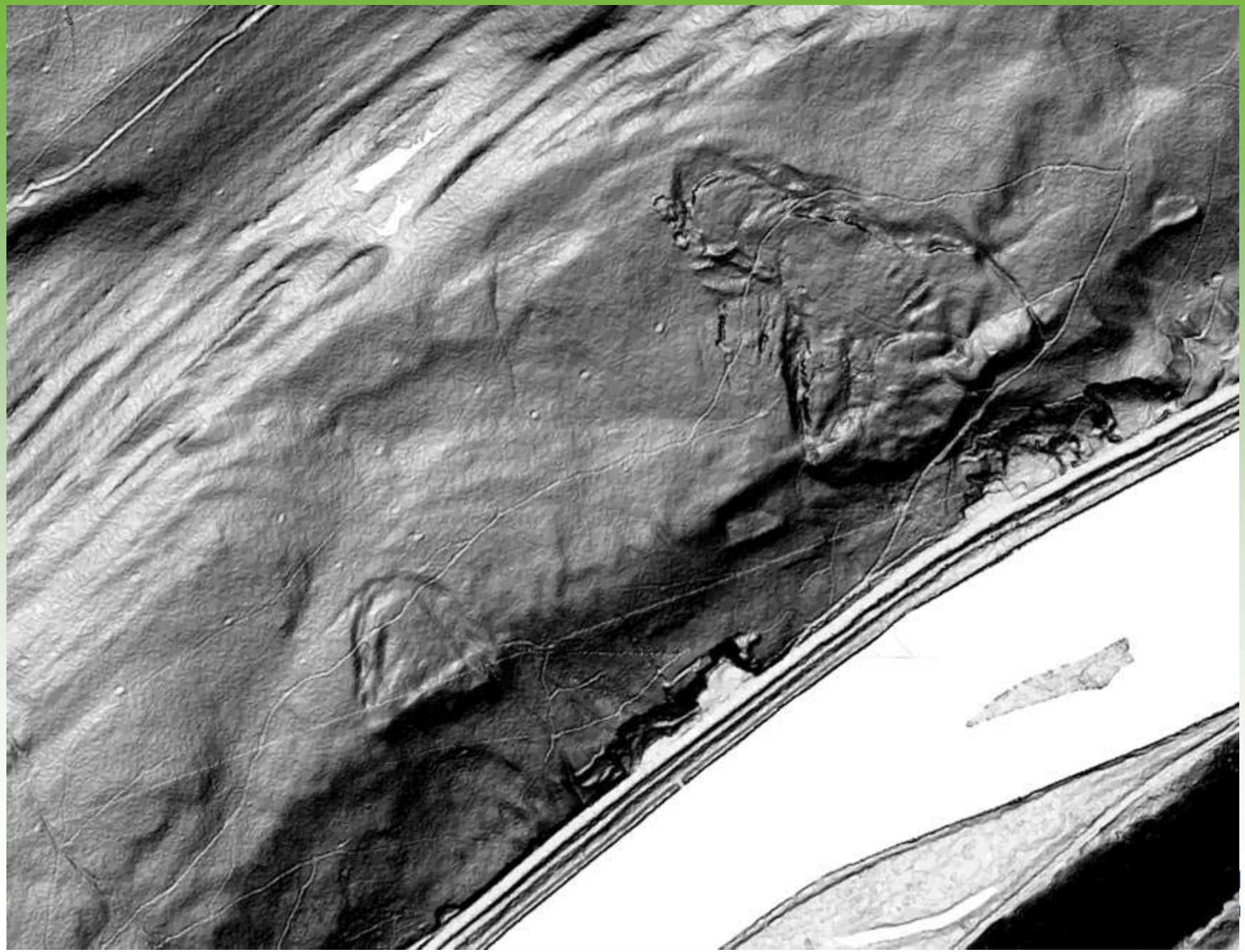

SORBER CEM
Reyburn
867
MOUNTAIN
SHICKSHINNY
RIVER
1400
1200
1000
800
1300
900
1100

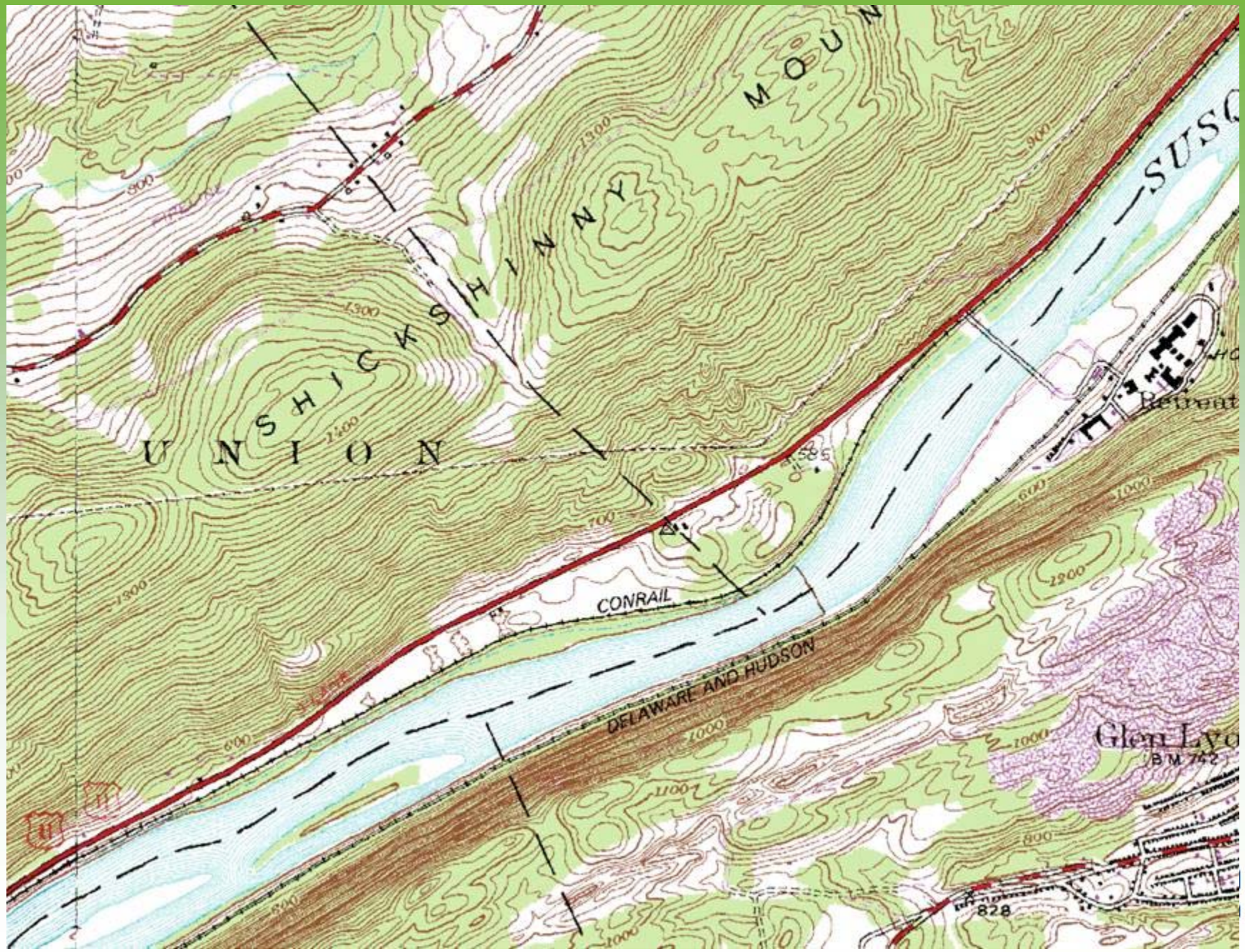


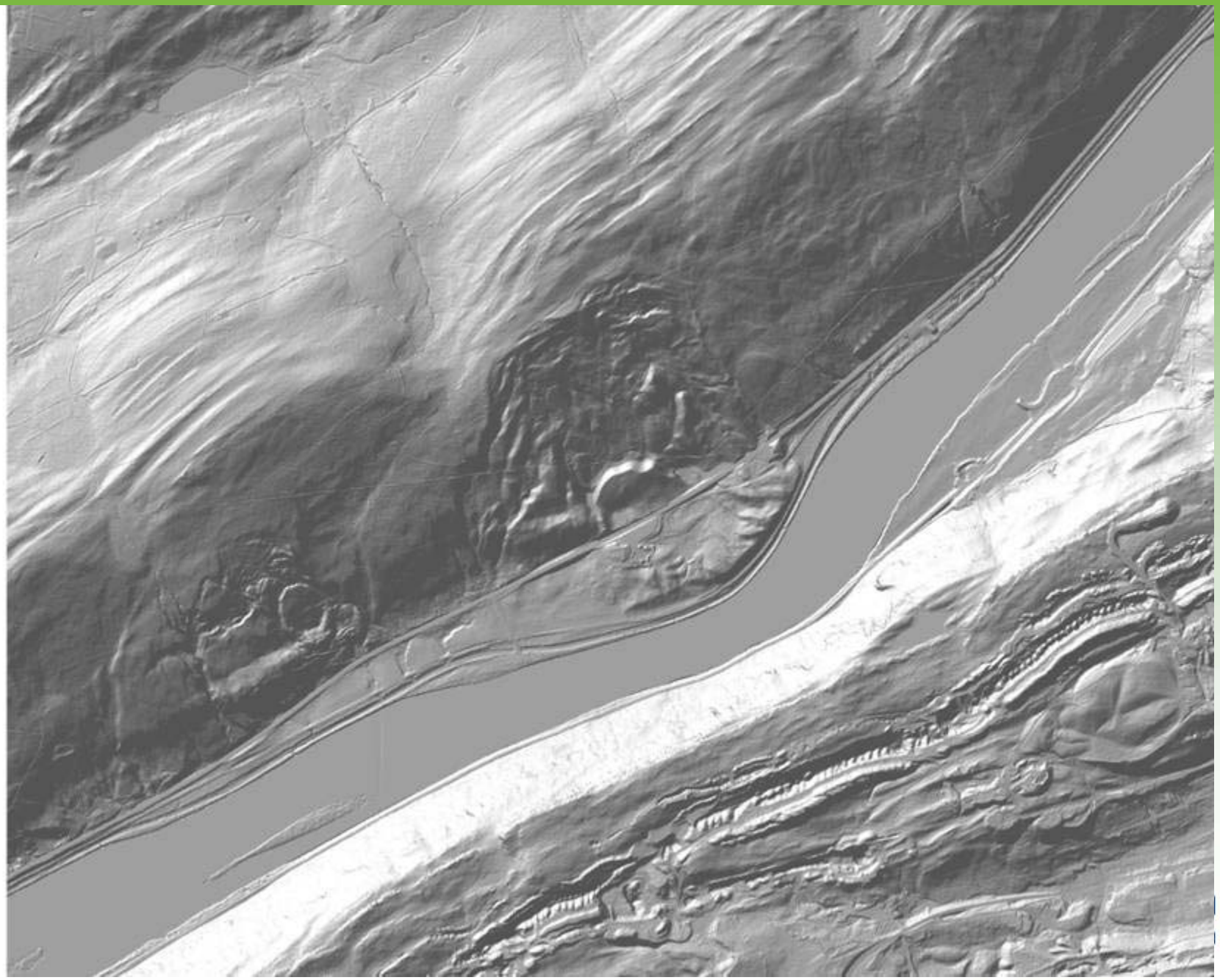


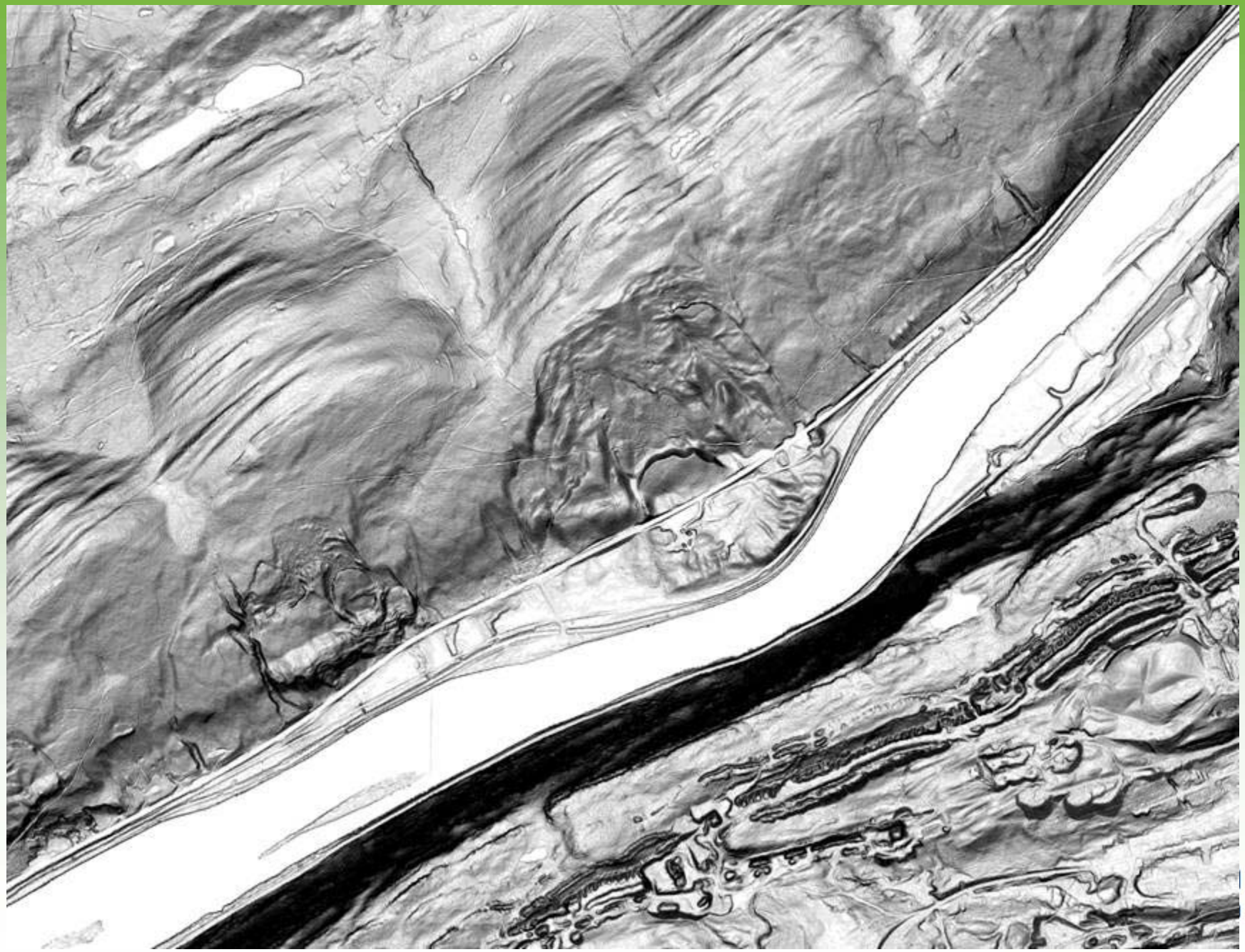

MOUNTAI
NY
1400
1000
1200
11
11

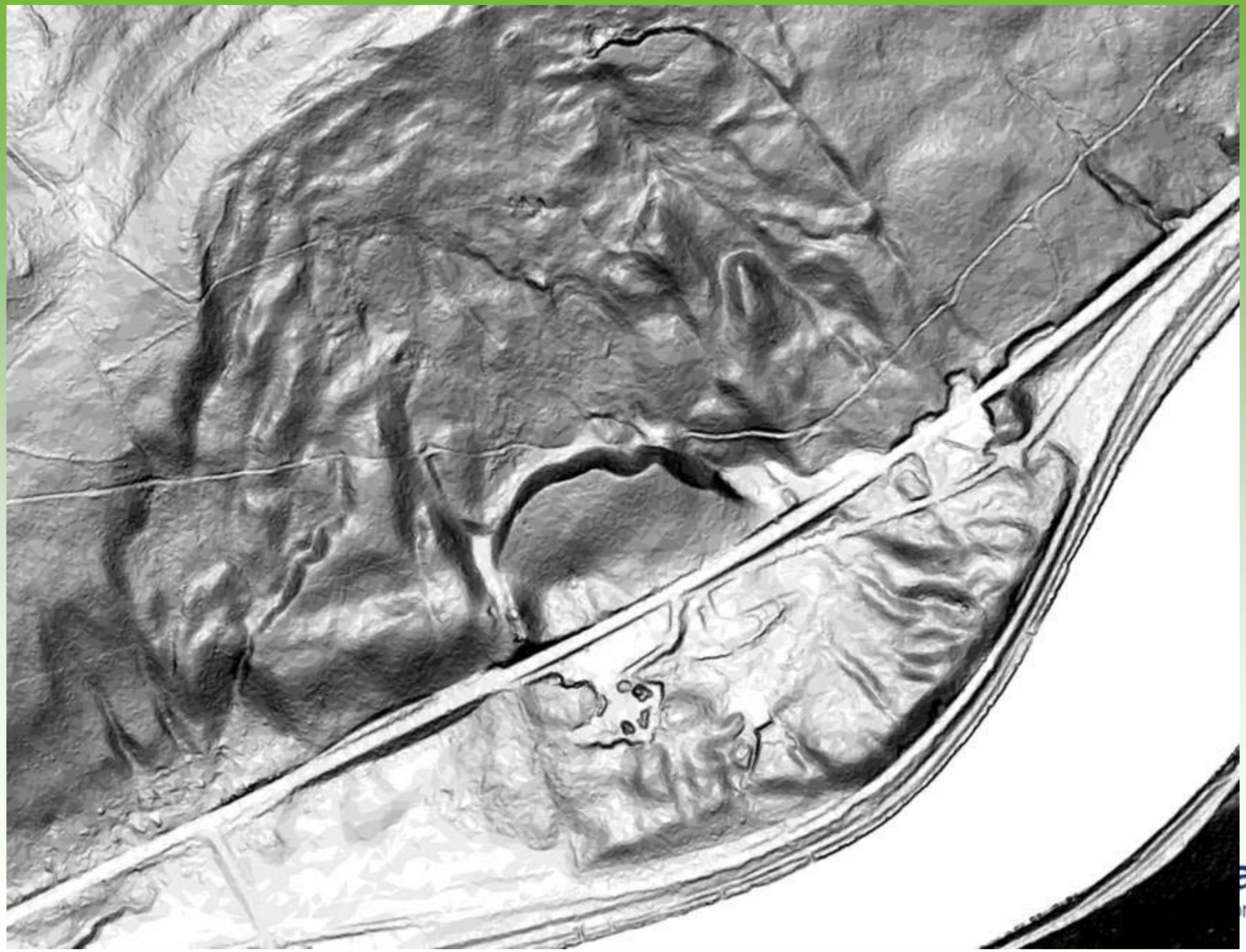


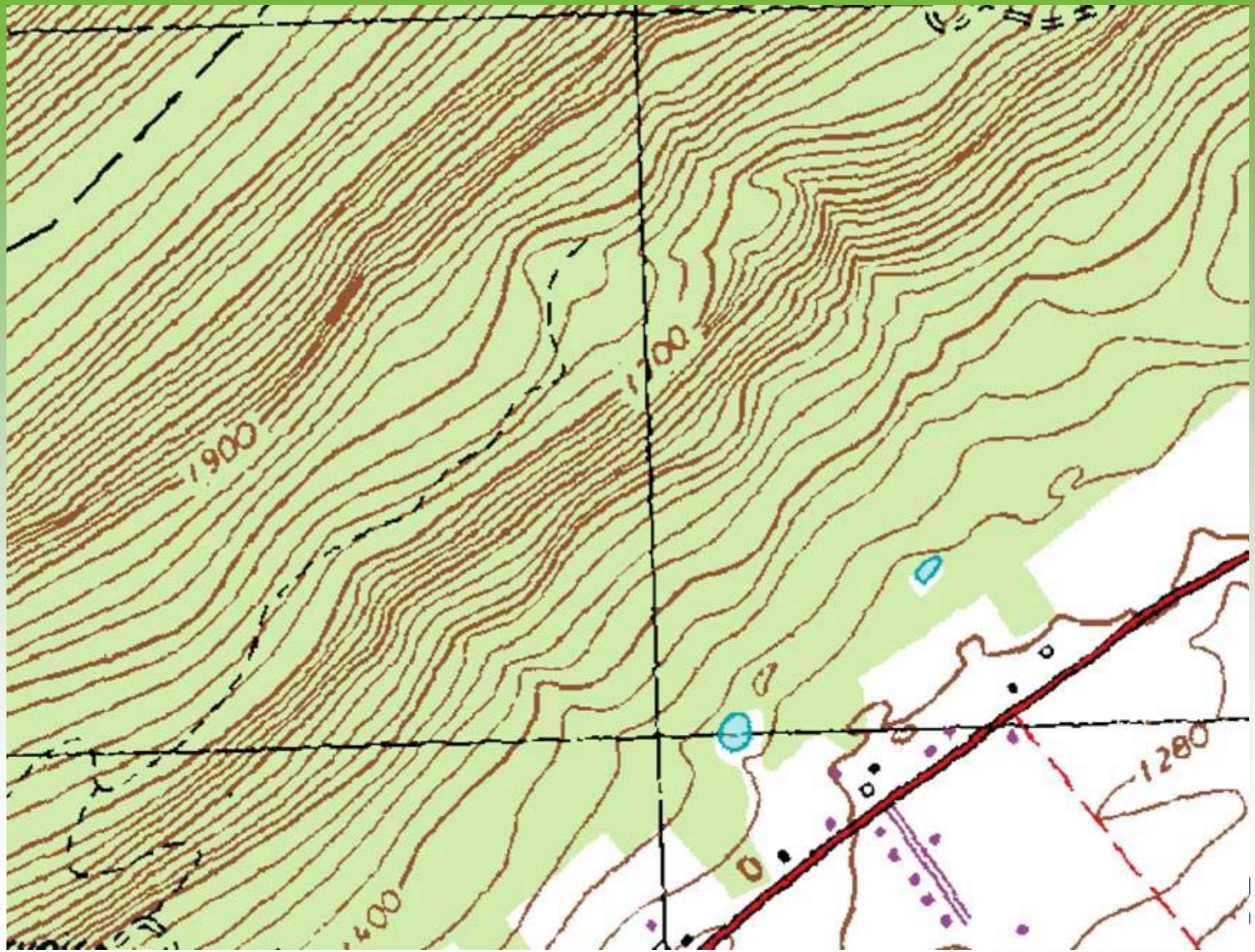


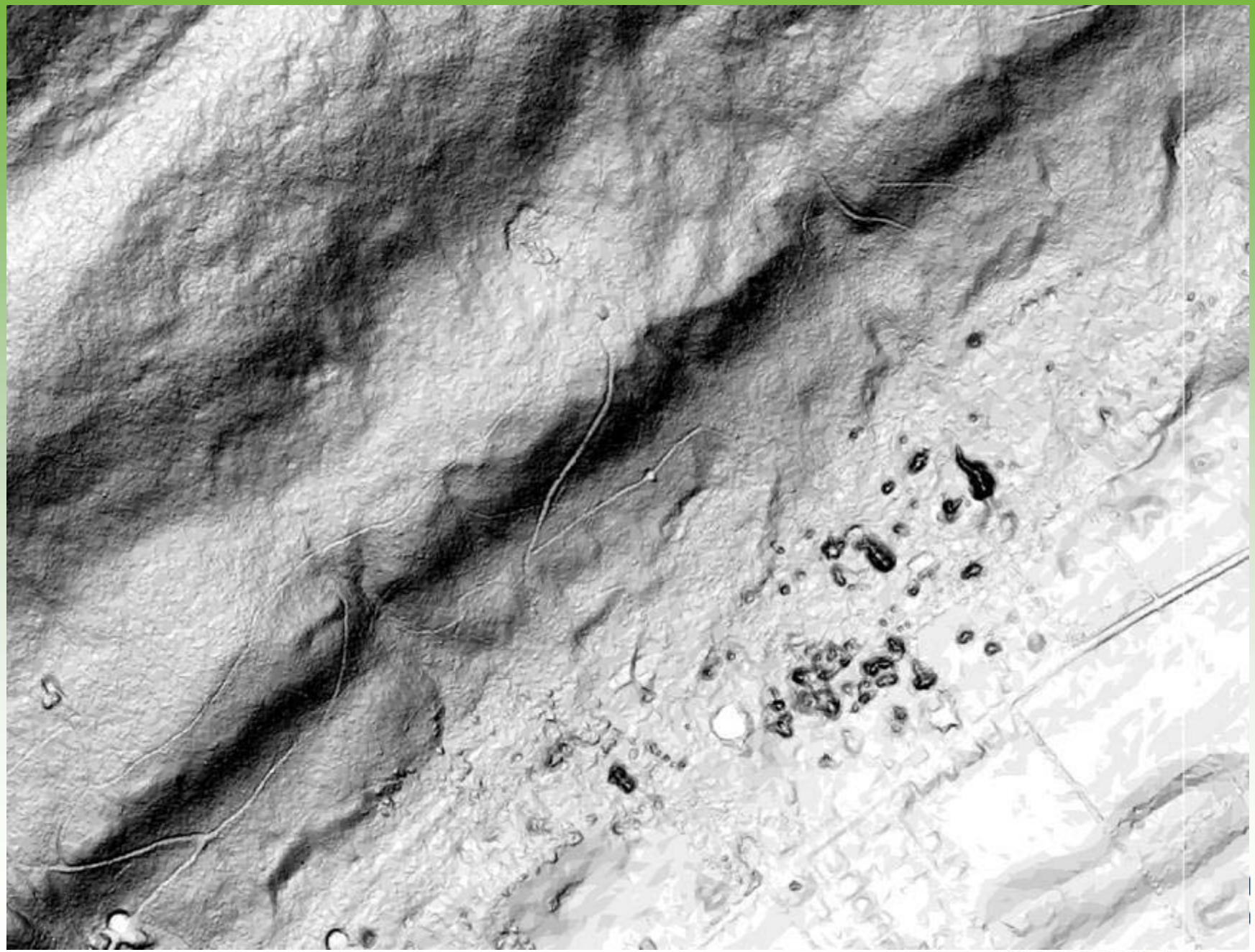

MOUN
SUSQ
UNSHICKSHINNY
CONRAIL
DELAWARE AND HUDSON
Glen Lyo
BM 742
828

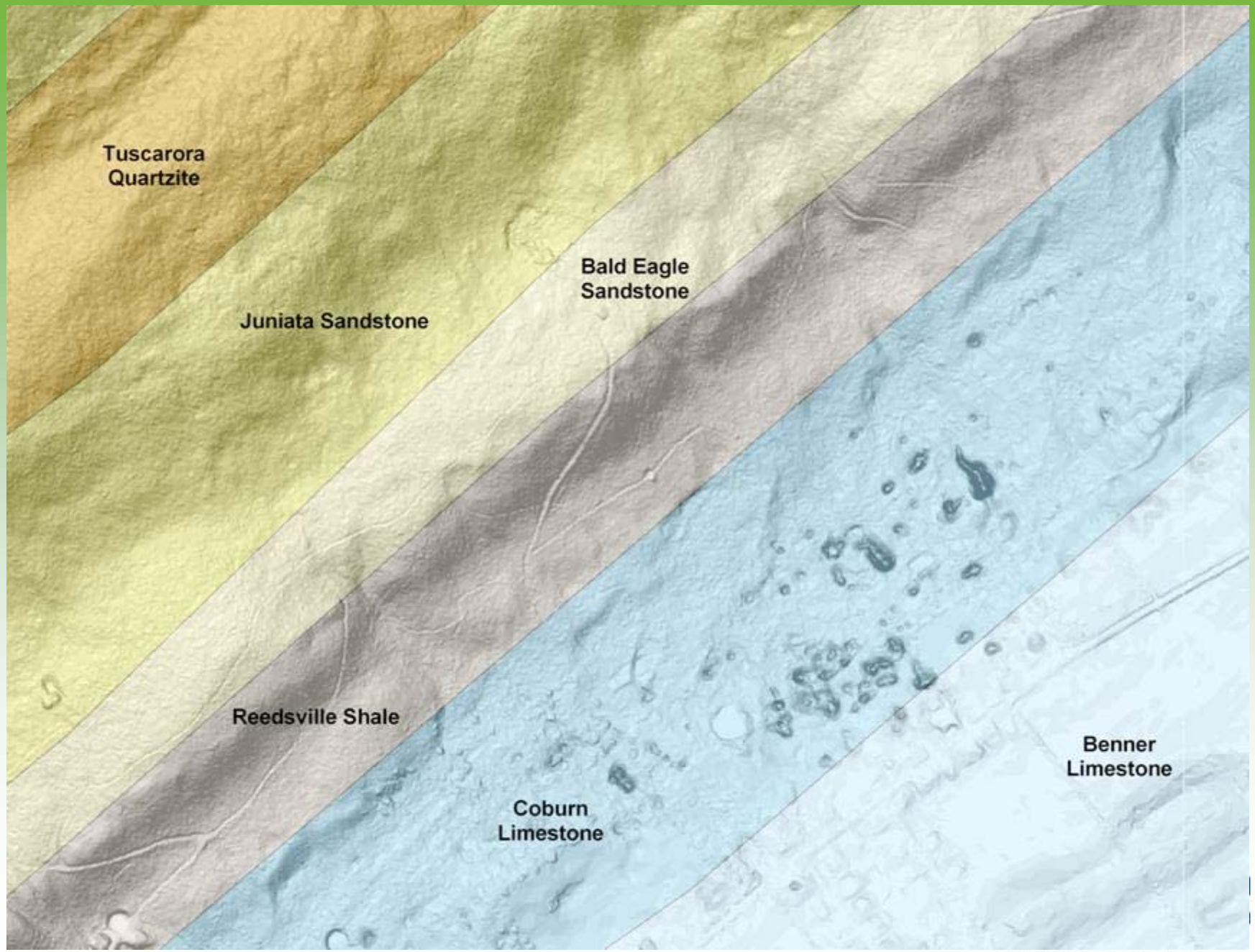


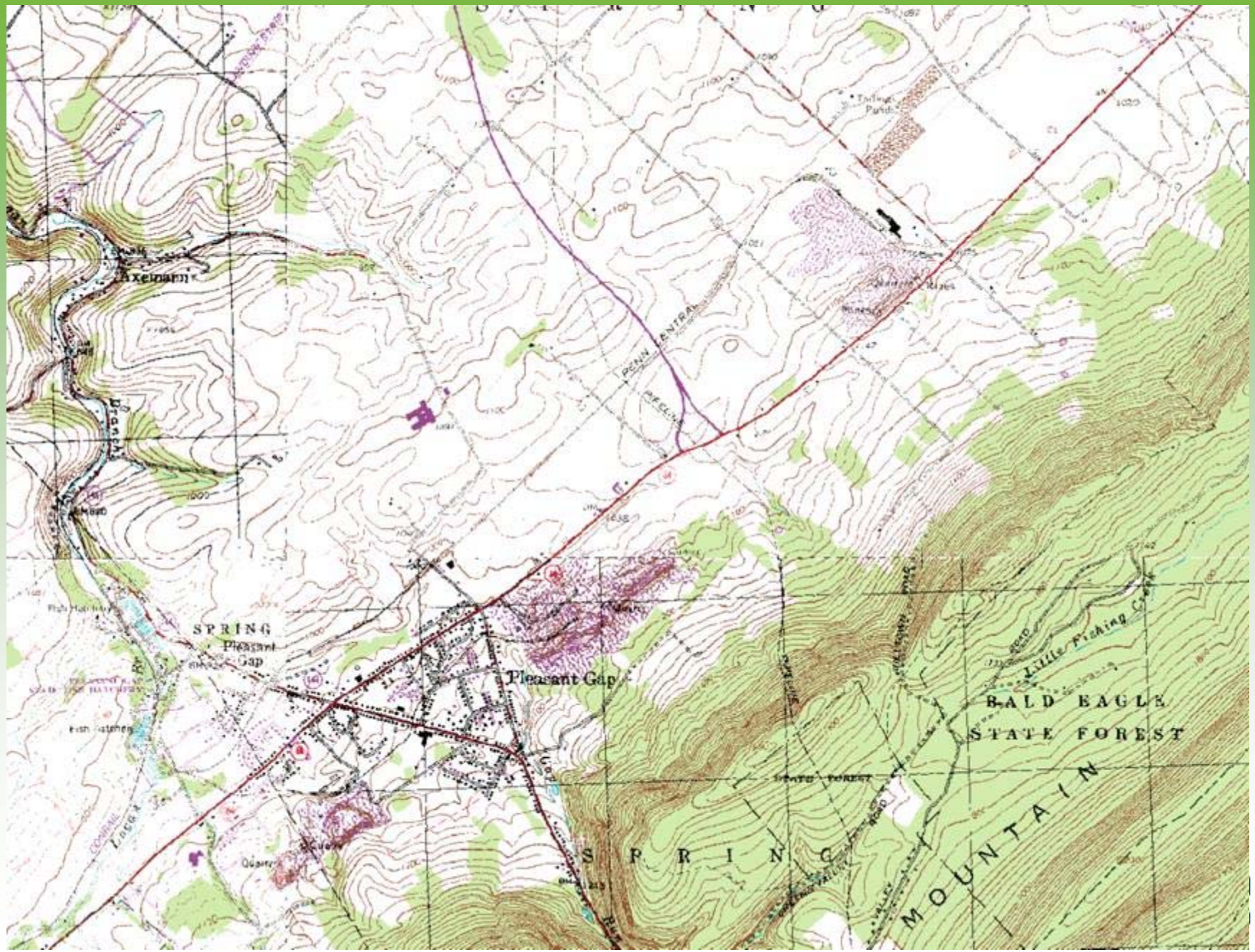


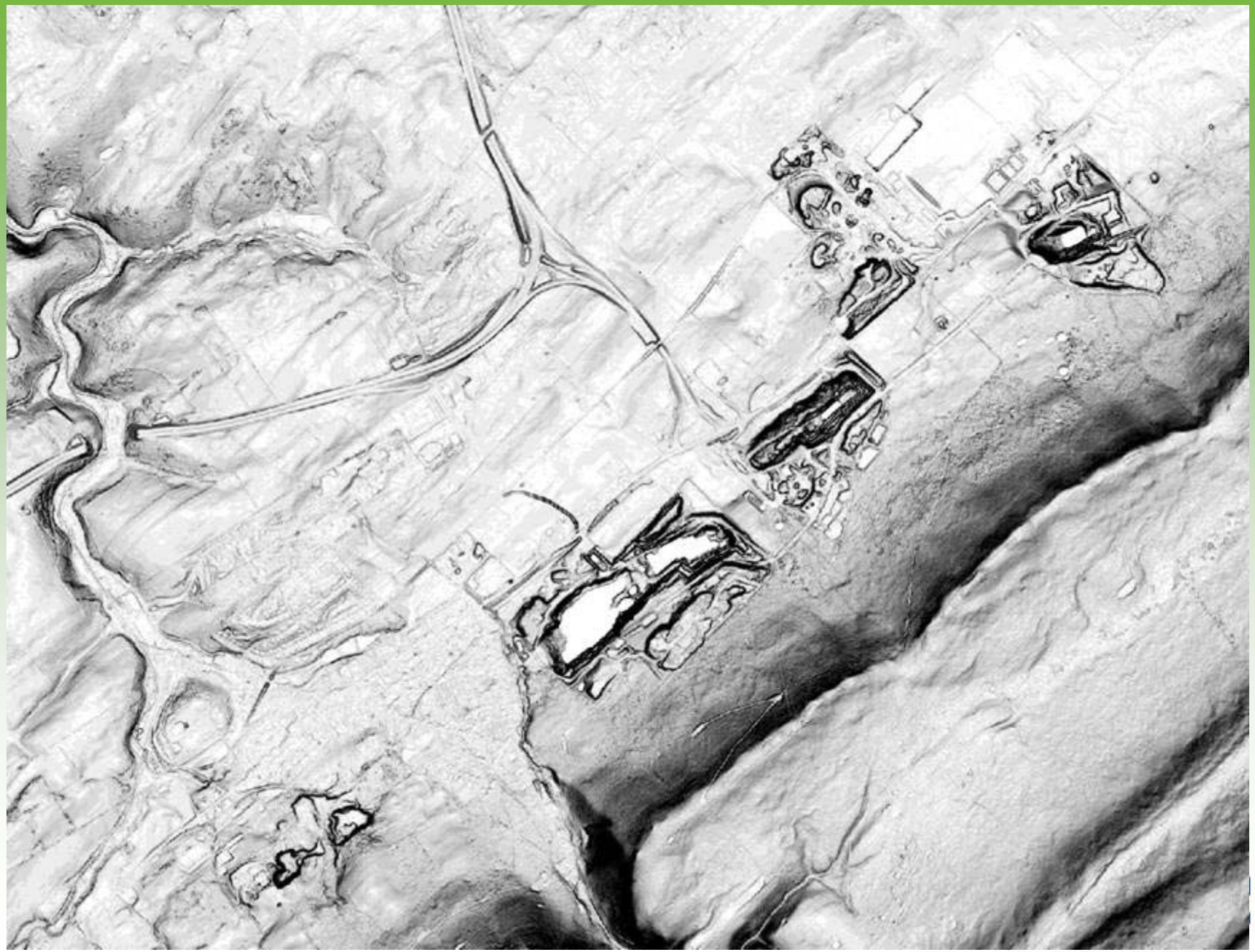


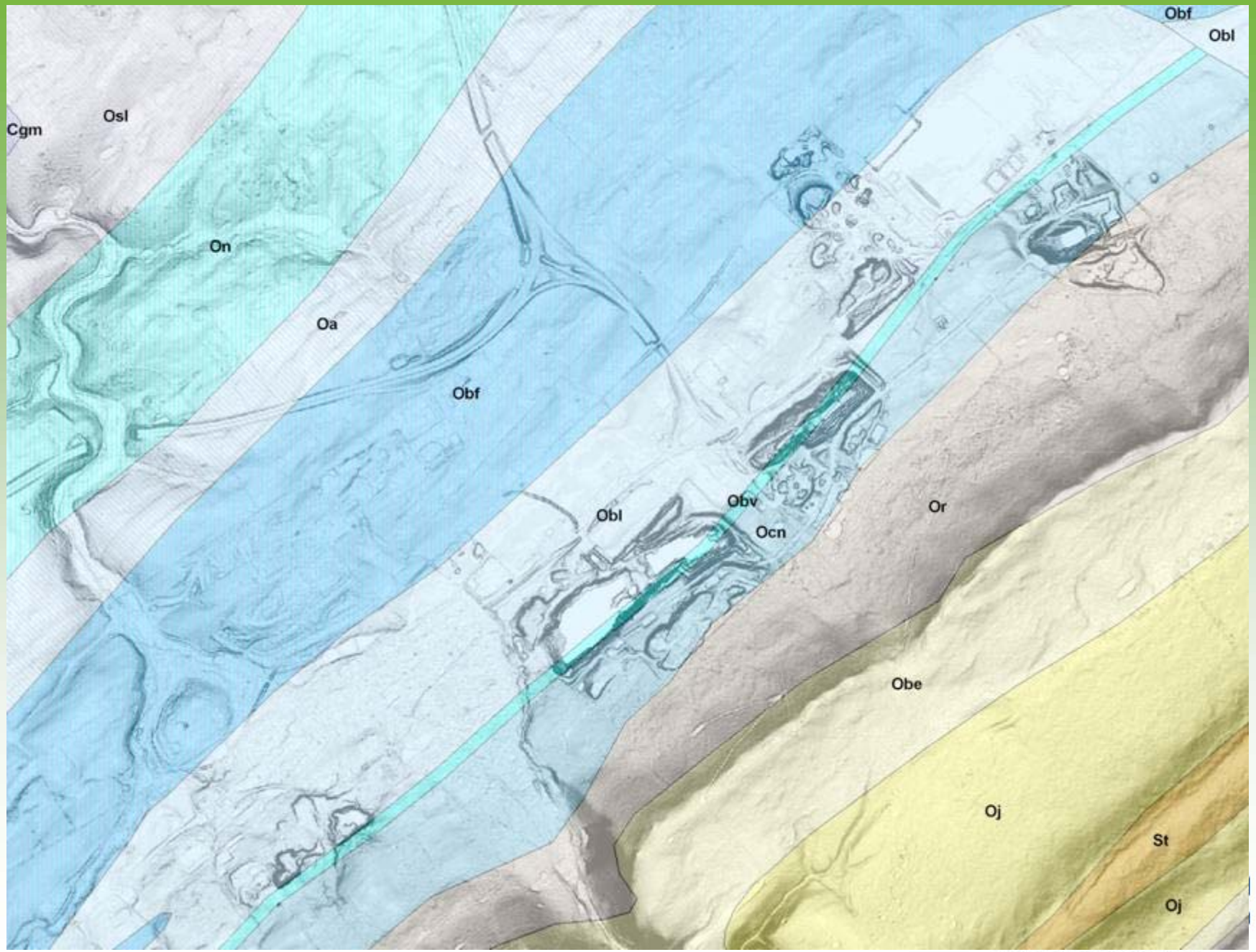

1900
1800
1400
1280




Tuscarora
Quartzite
Juniata Sandstone
Bald Eagle
Sandstone
Reedsville Shale
Coburn
Limestone
Benner
Limestone


Axemann
Branch
SPRING
Pleasant
Gap
Pleasant Gap
PENN CENTRAL
Little Fishing Creek
BALD EAGLE
STATE FOREST
MOUNTAIN
SPRING

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Questions?

twhitfield@state.pa.us

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