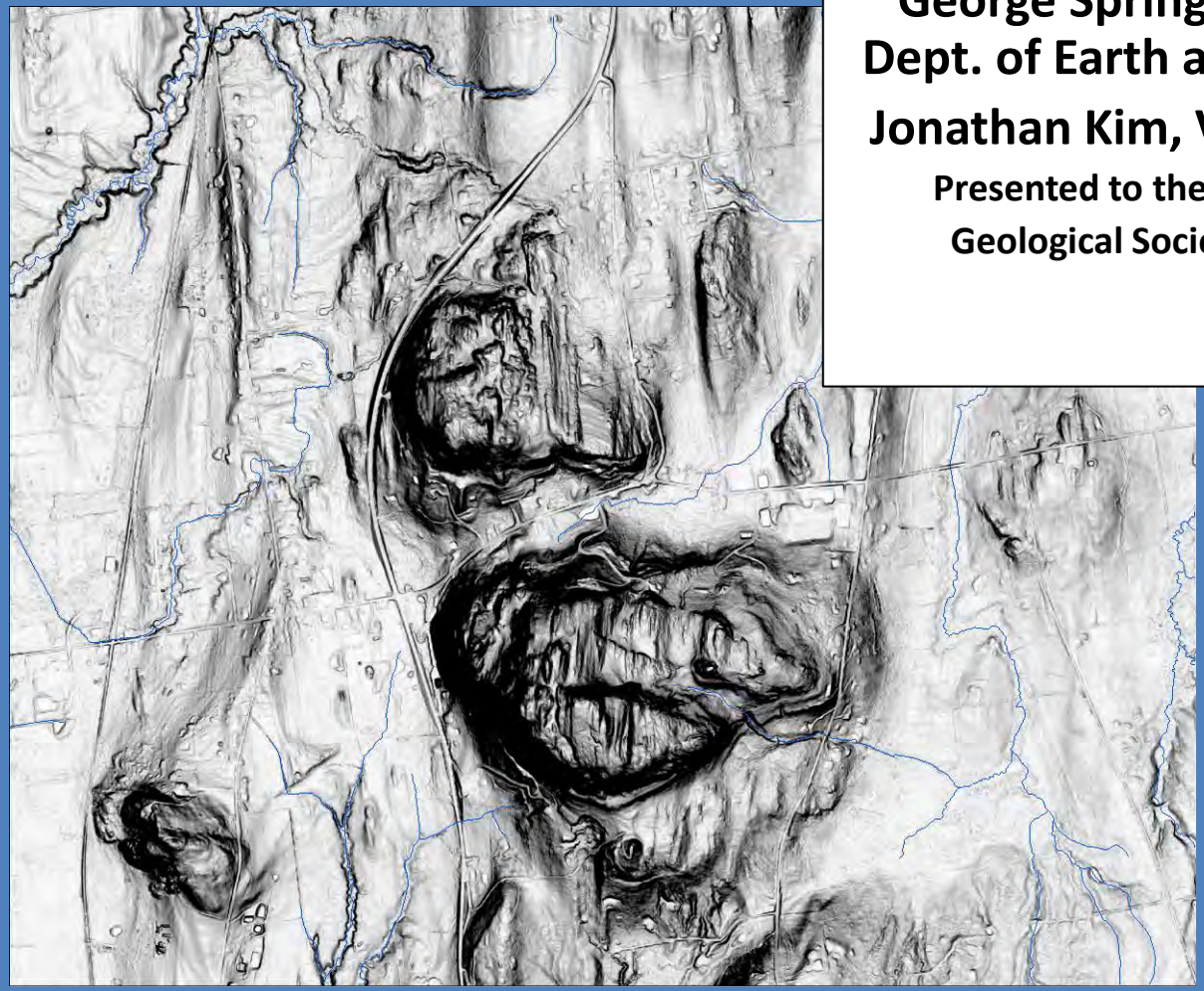
Surficial Features and Bedrock Structures Revealed by Lidar in Western Vermont

George Springston, Norwich University, Dept. of Earth and Environmental Sciences

Jonathan Kim, Vermont Geological Survey

Presented to the Northeastern Section Meeting, Geological Society of America, Bretton Woods, New Hampshire

March 24, 2015



0 500 1,000 1,500 2,000 Meters

N

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VERMONT
AGENCY OF NATURAL RESOURCES
Vermont Geological Survey

NORWICH UNIVERSITY™
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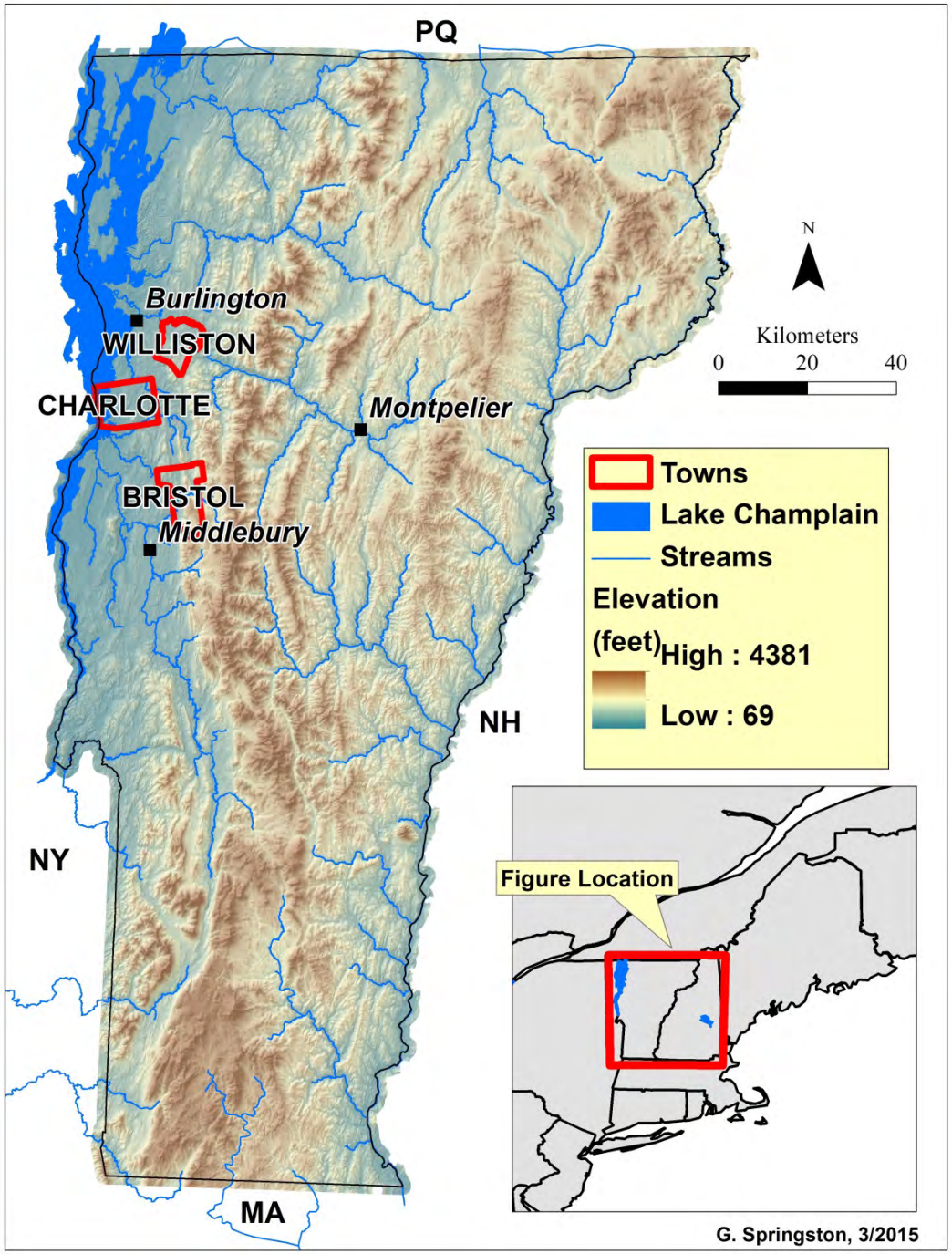
Outline

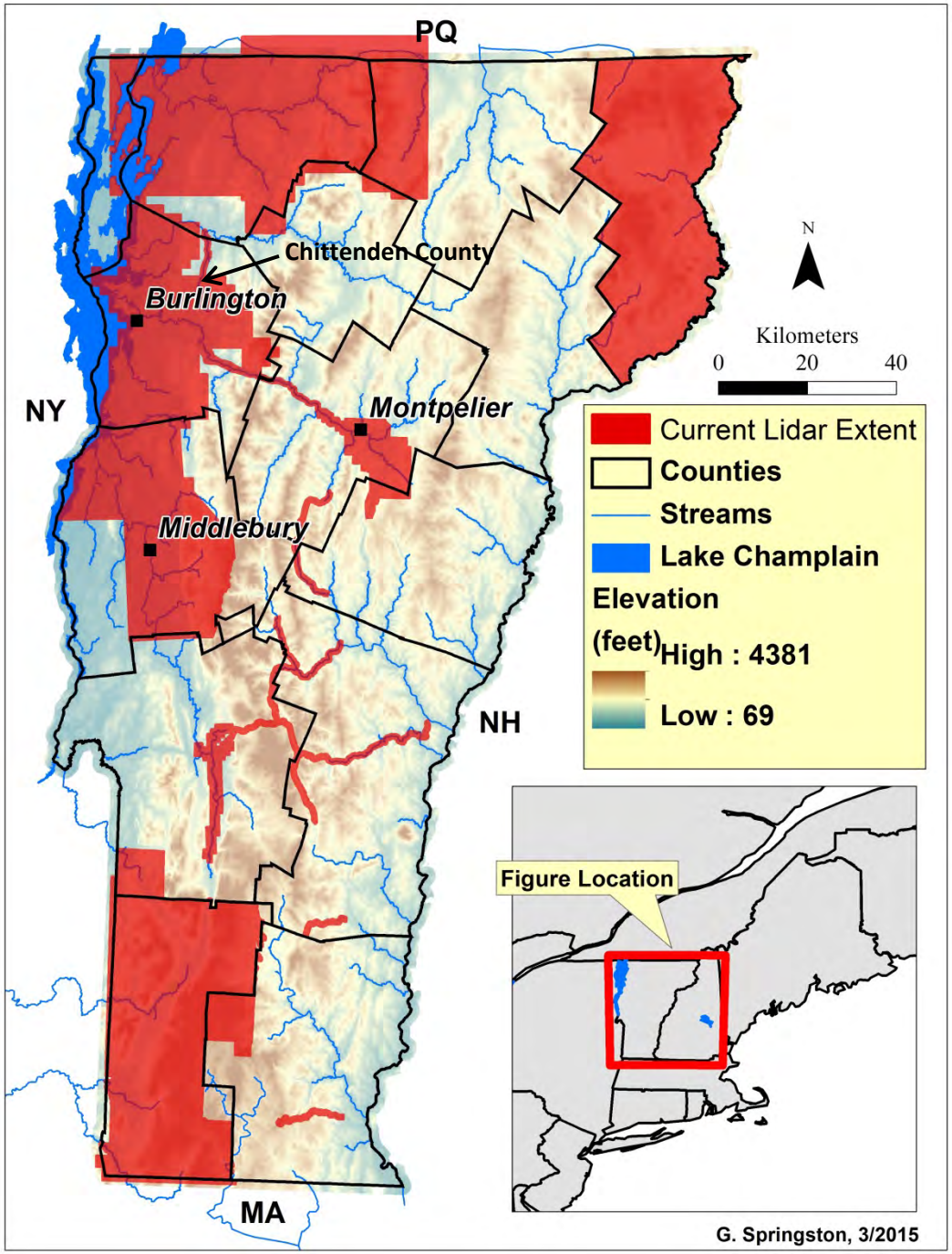
1. Introduction to VT lidar data
2. Analysis of Surficial Features
3. Analysis of Bedrock Structures
4. Summary and Future Efforts



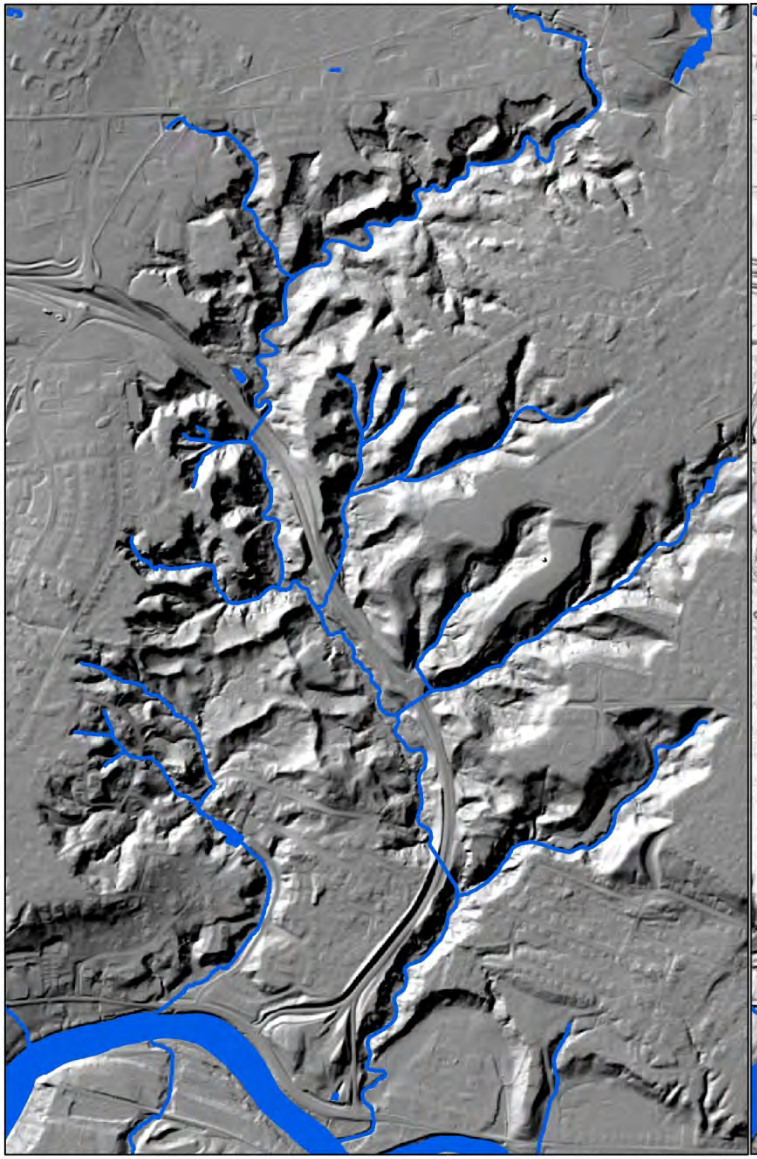
Current Extent of Lidar Topographic Data in Vermont

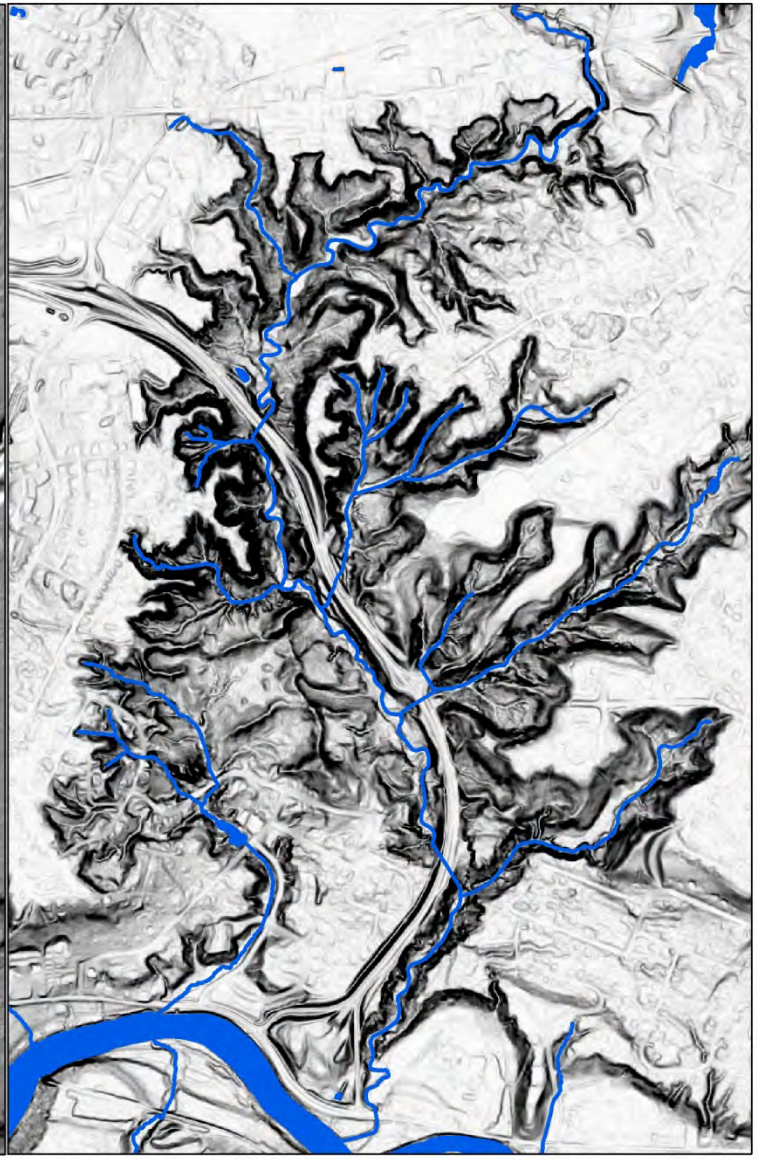
The principal lidar-derived products that we're working from are bare-earth digital elevation models (DEMs) .

Most of the data in Chittenden County is available as 3.2 meter DEMs; the remainder is available as 1.6 to 1.0 meter DEMs. Some of the new data will be 0.7 meter DEMs.



Shaded Relief Map (left) and Percent Slope Map (right) of Alder Brook Watershed in Essex, Chittenden County.





Streams

Water Bodies

Shaded Relief

Value

High : 254

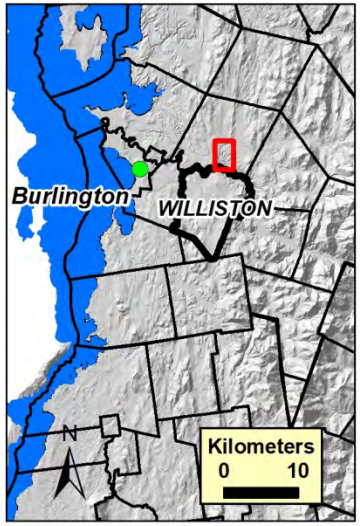
Low : 0

Slope (Percent)

Value

High : 136.361

Low : 0.00444844



0 500 1,000 1,500 2,000 Meters

N

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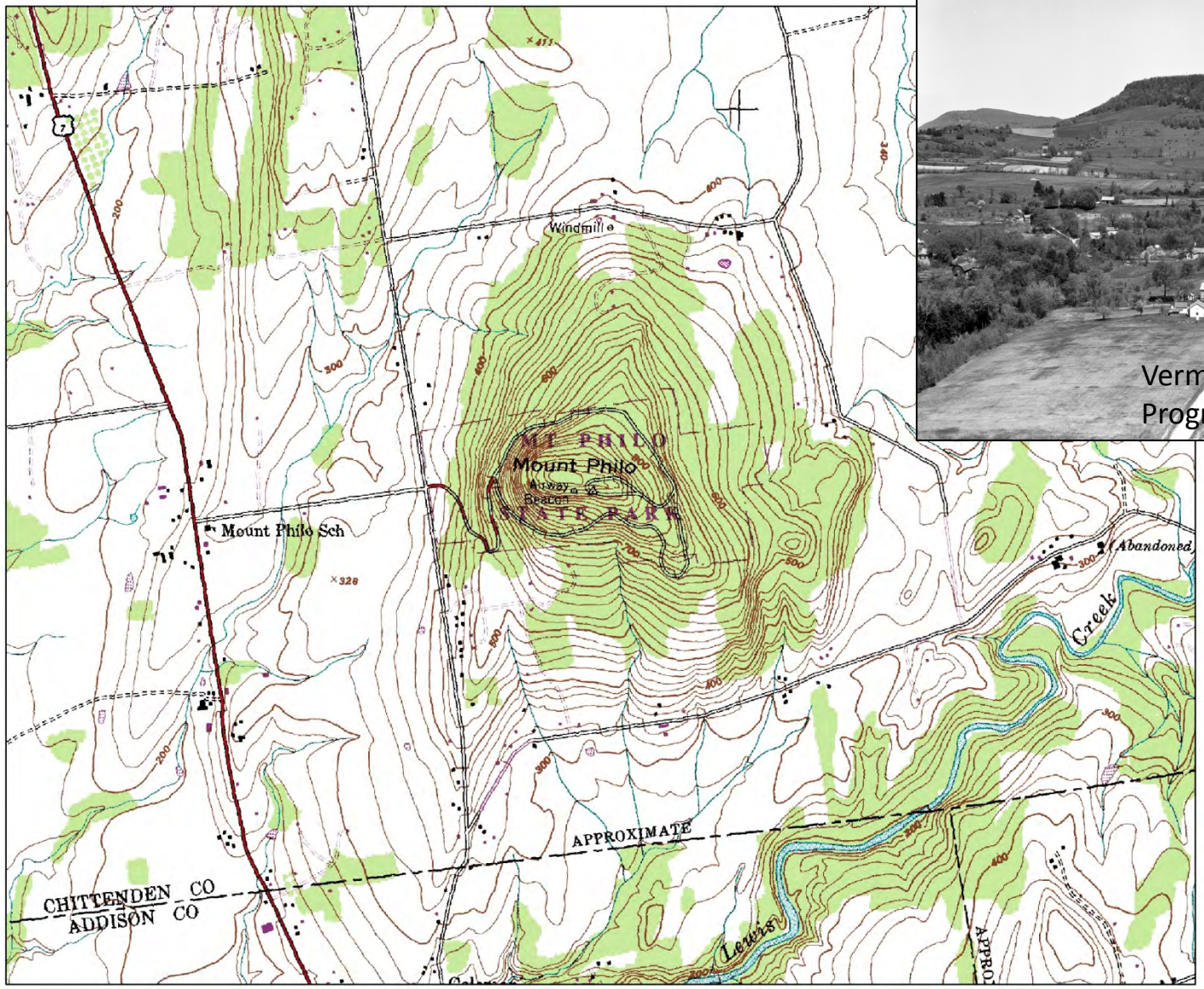
Shorelines and Bedrock Outcrops at Mt. Philo in Charlotte, Chittenden County

Vermont Landscape Change Program, LS18328, 1941



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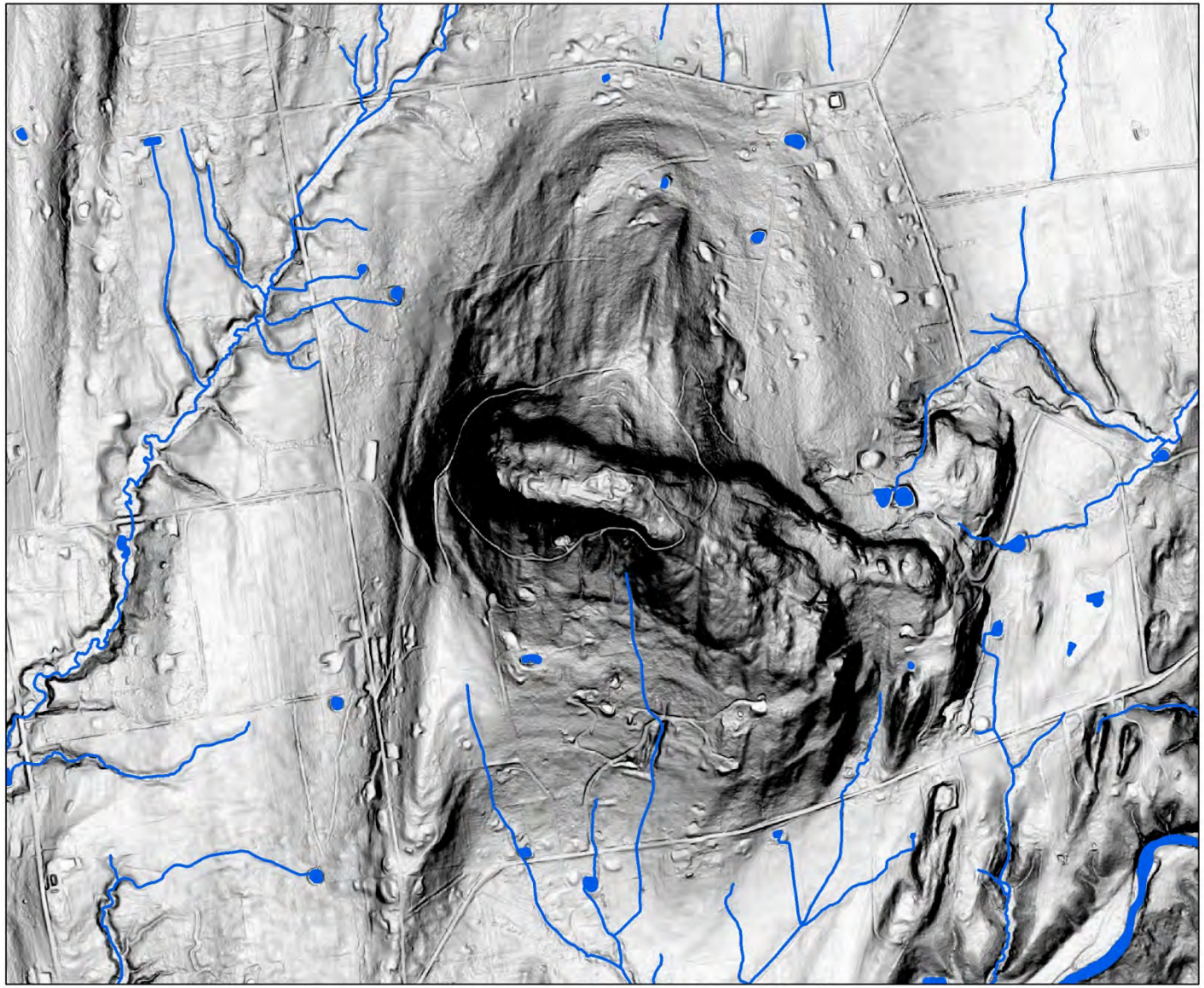
Shorelines and Bedrock Outcrops at Mt. Philo in Charlotte, Chittenden County



Streams

Water Bodies

Slope (Percent)

High

Low

0 500 1,000 1,500 Meters

N

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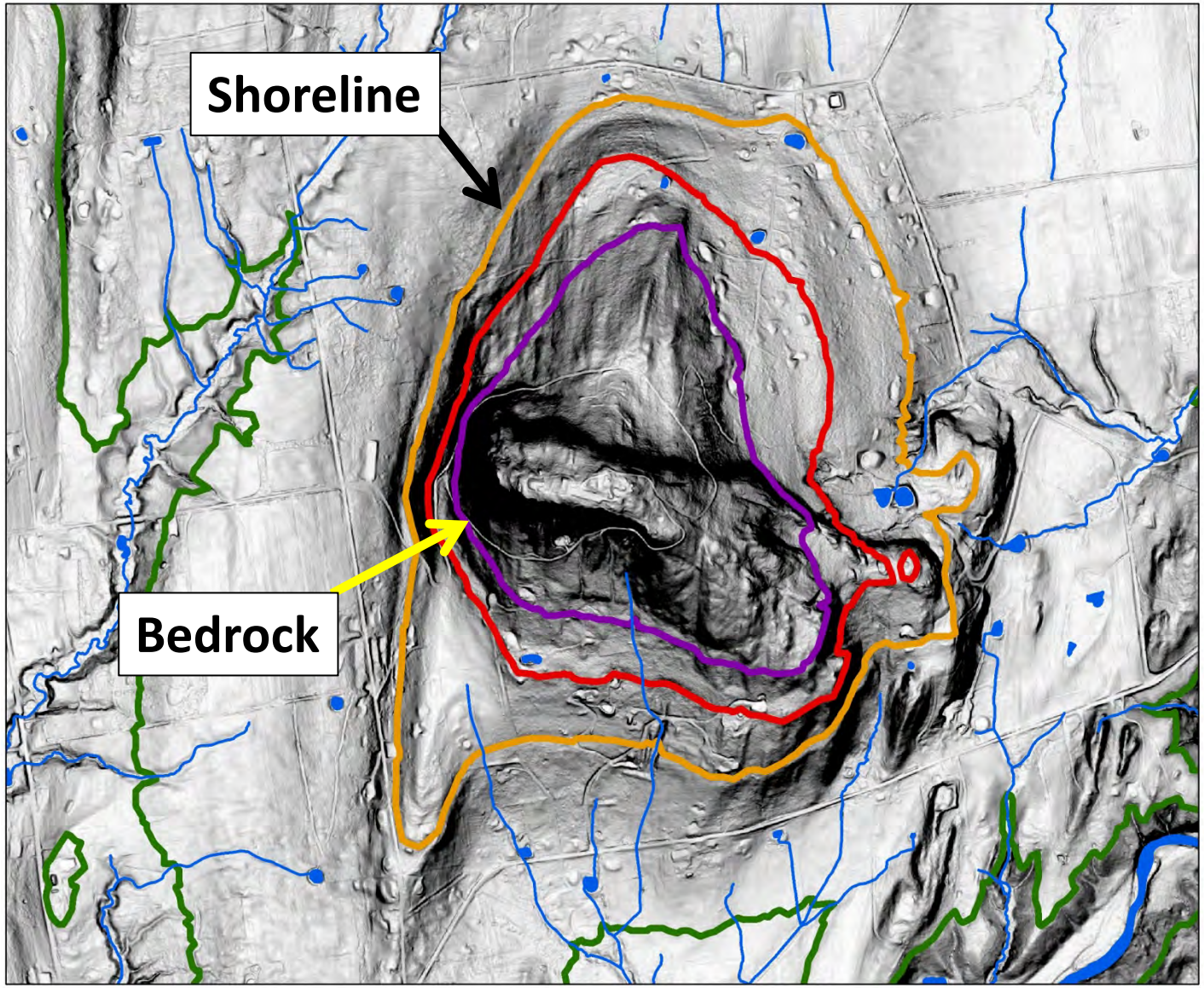
Shorelines and Bedrock Outcrops at Mt. Philo in Charlotte, Chittenden County



Streams
Water Bodies
Coveville Shoreline
Upper Fort Ann Shoreline
Lower Fort Ann Shoreline
Champlain Sea Shoreline
Slope (Percent)
High
Low

0 500 1,000 1,500 Meters

N

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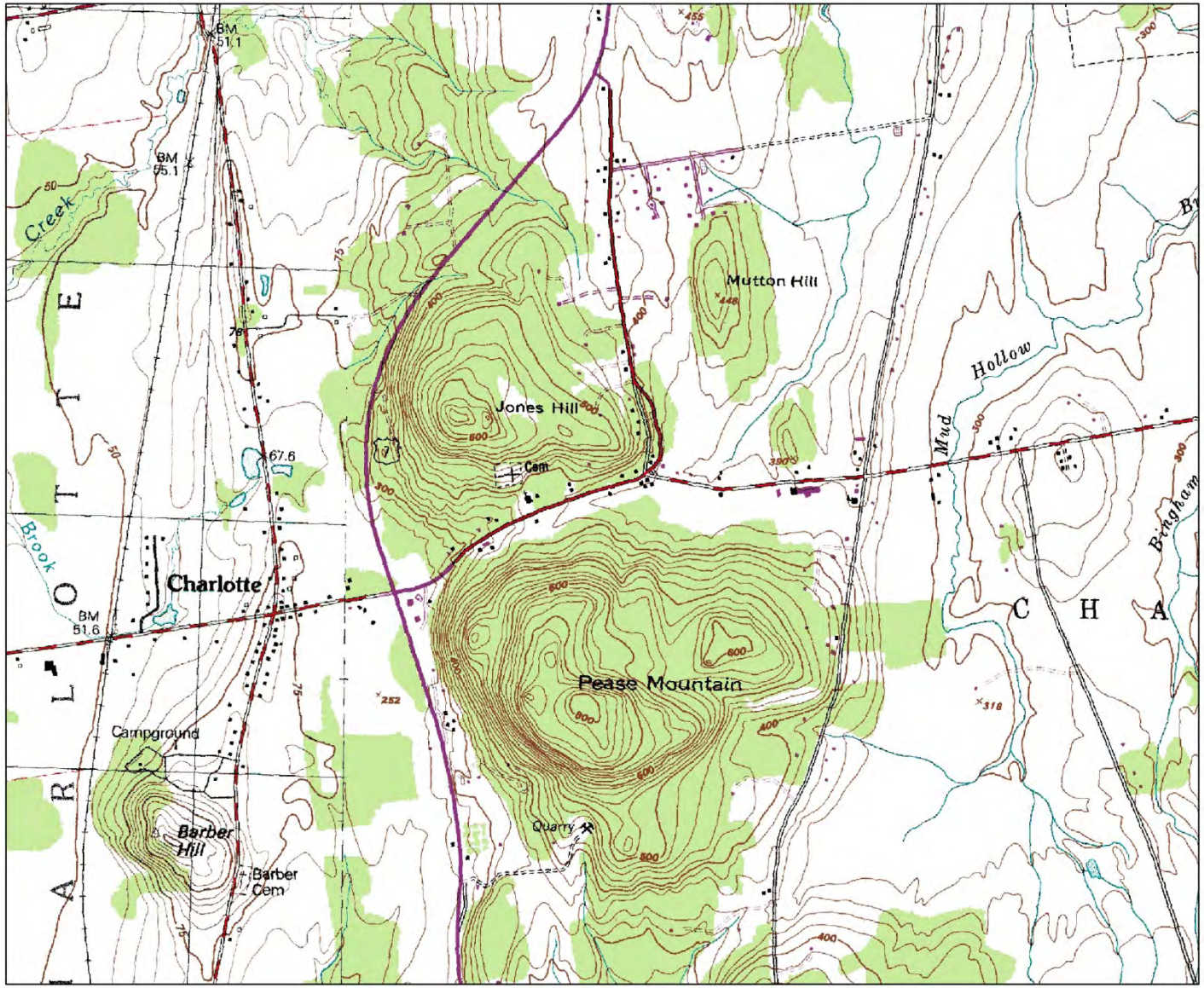
Beaches and Shorelines on Pease Mountain in Charlotte



0 500 1,000 1,500 2,000 Meters

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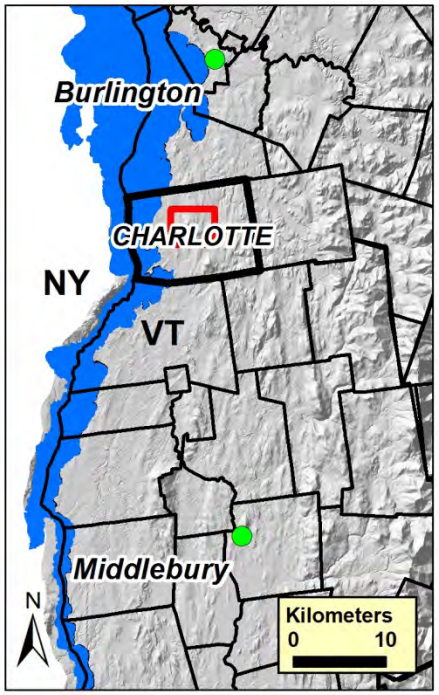
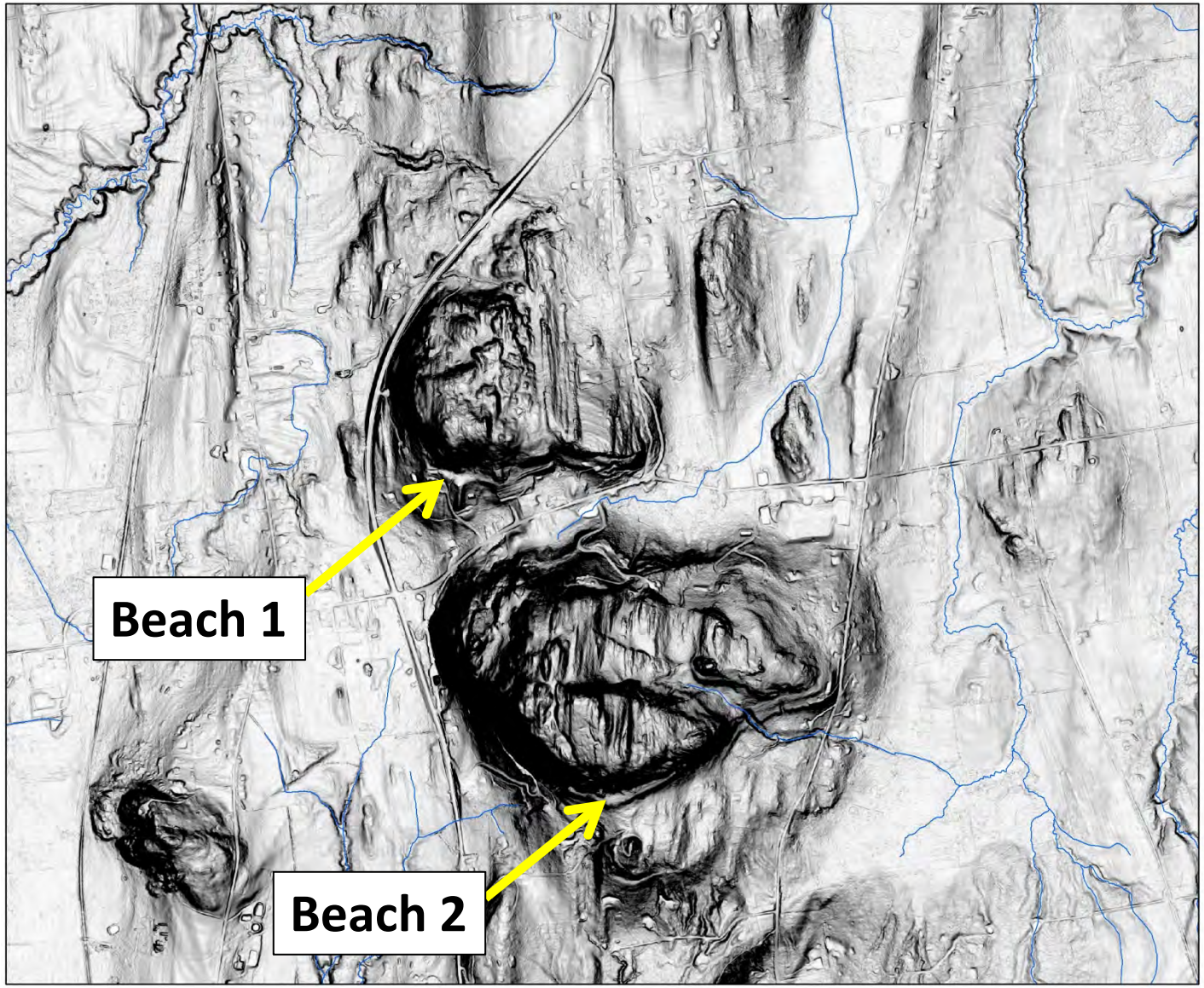
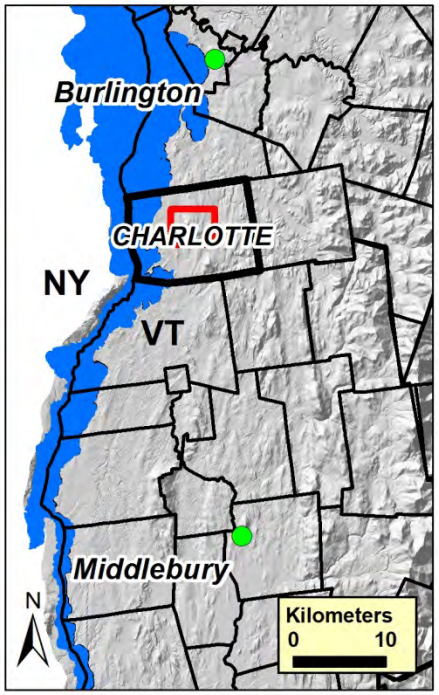


Beaches and Shorelines on Pease Mountain in Charlotte



Profile
Streams
Slope (Percent)
High
Low



0 500 1,000 1,500 2,000 Meters

N

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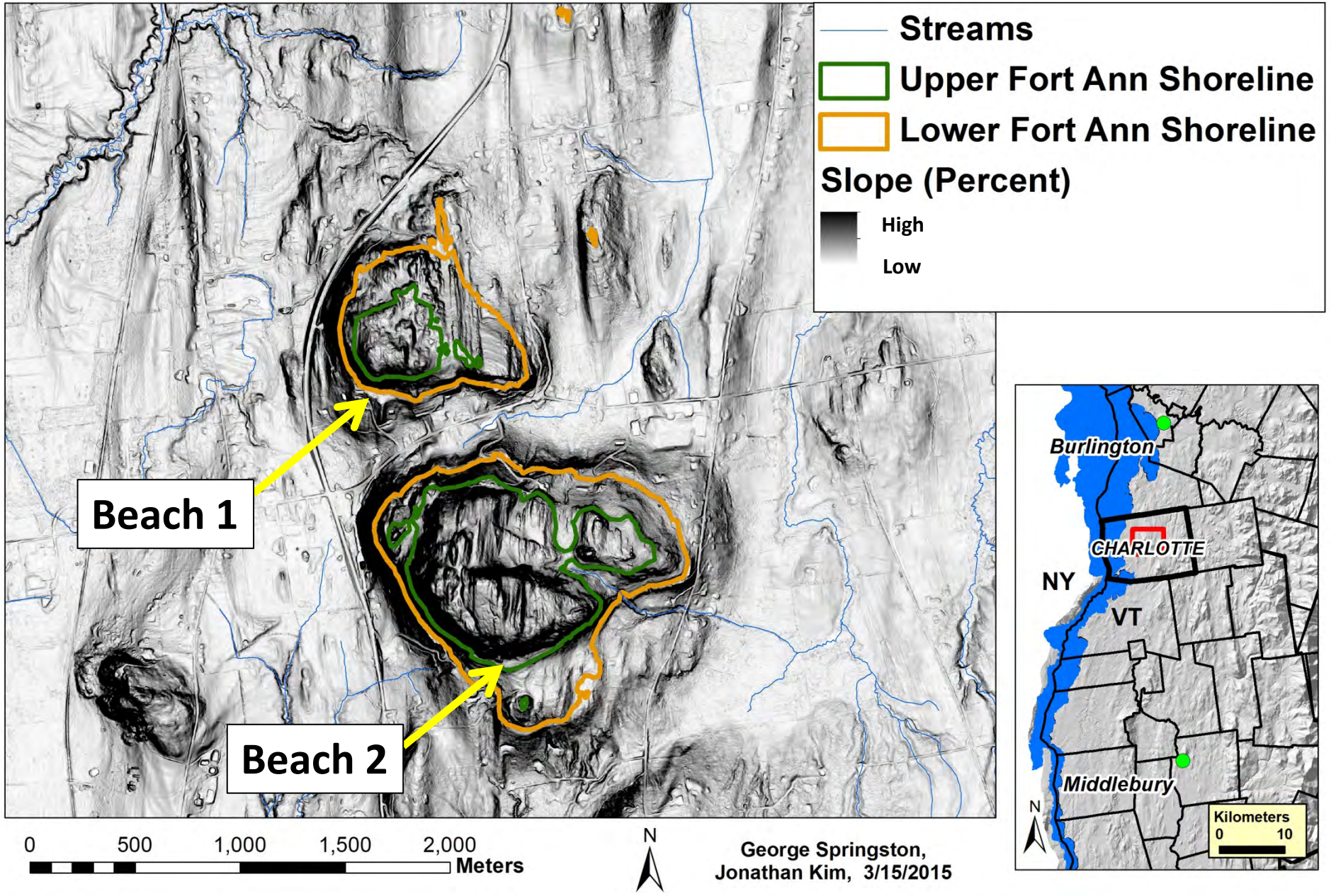
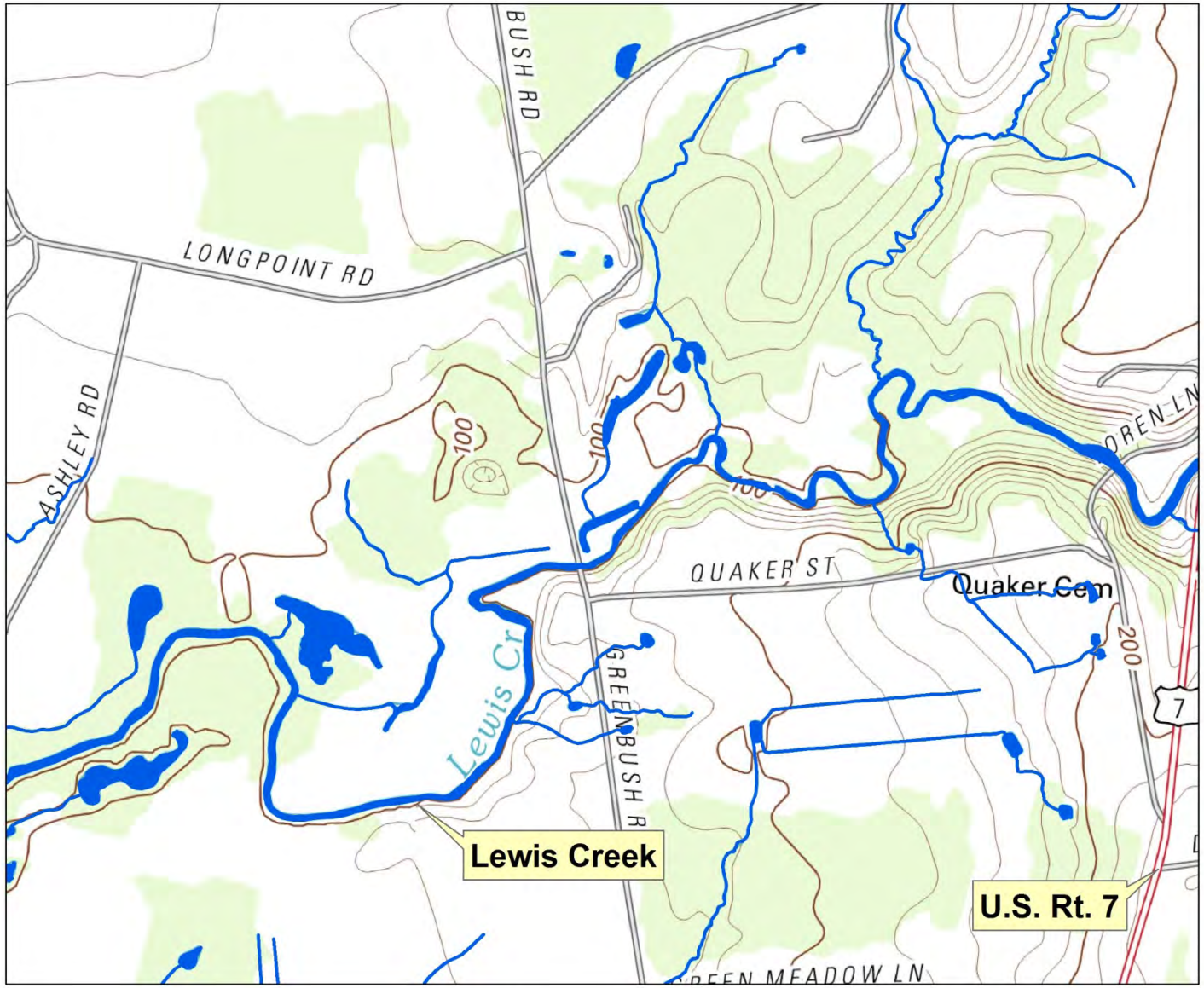
Beaches and Shorelines on Pease Mountain in Charlotte



Landslides on Lewis Creek in Ferrisburg, Addison County



Streams

Water Bodies

Slope (Percent)

High

Low

0 500 1,000 Meters

N

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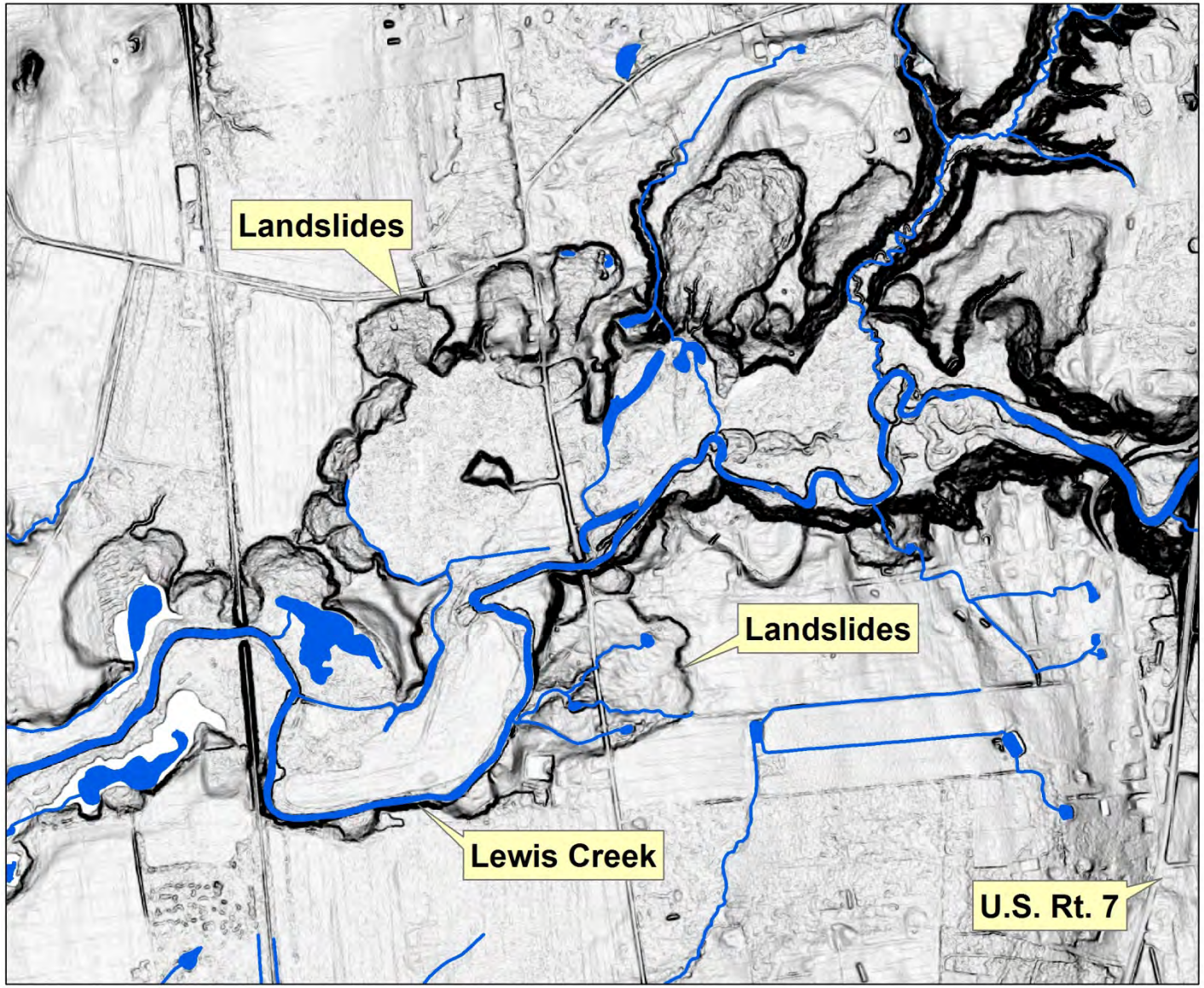
Landslides on Lewis Creek in Ferrisburg, Addison County



Streams
Water Bodies
Slope (Percent)
High
Low

0 500 1,000 Meters

N

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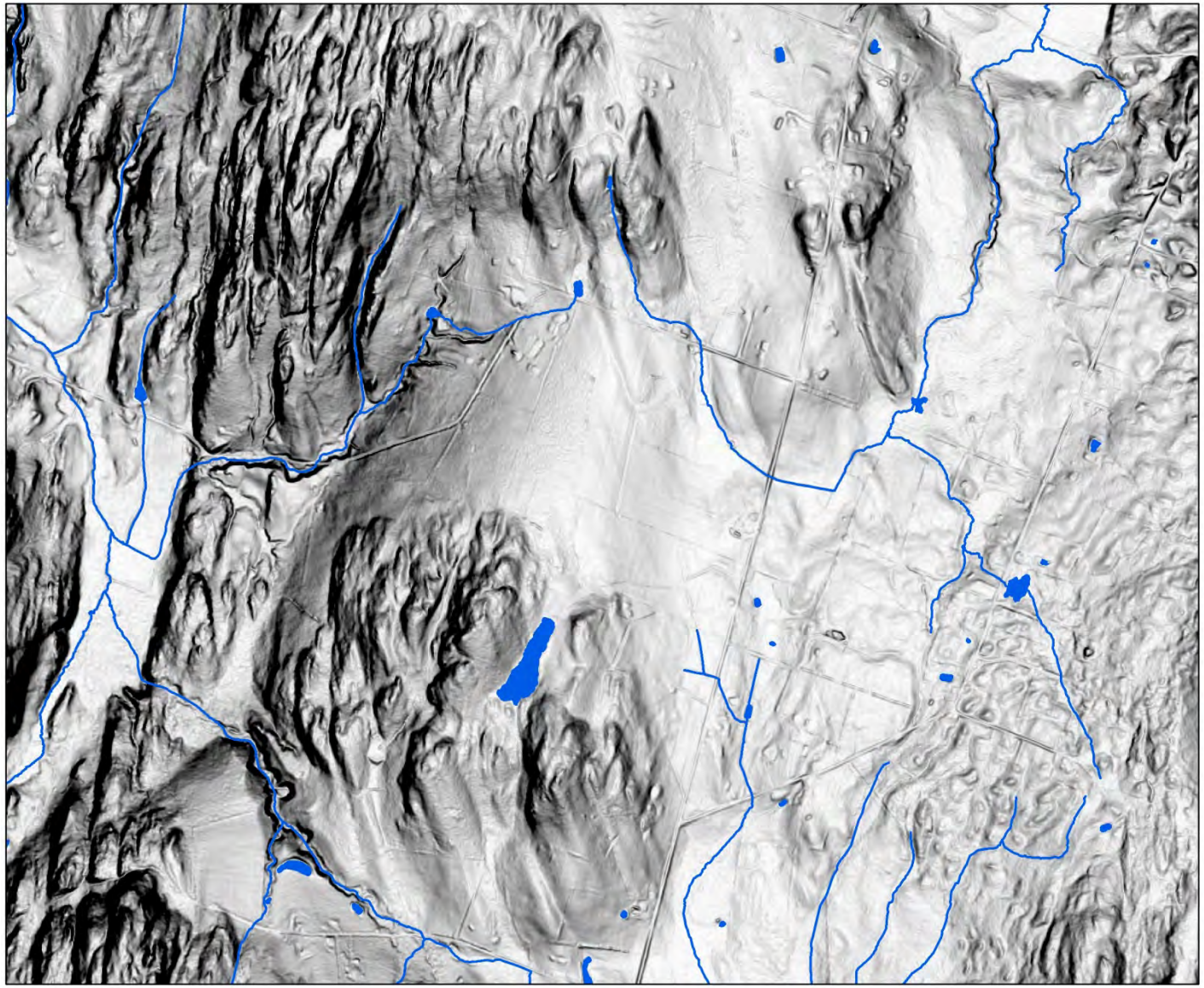
Crag and Tail Landforms in Williston, Chittenden County



Streams

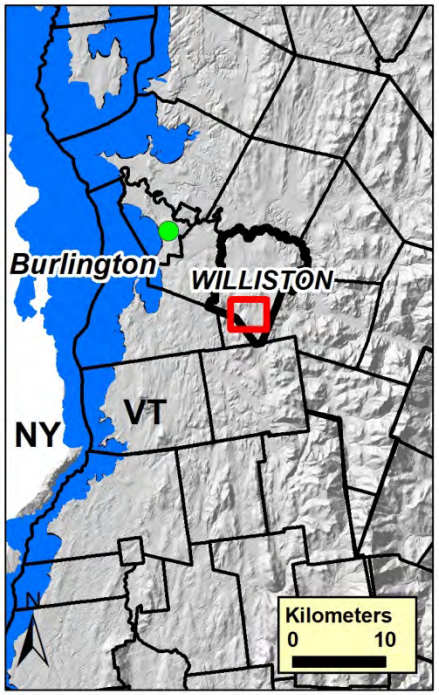
Water Bodies

Slope (Percent)

Value

High : 222.267

Low : 0.0100536



0 500 1,000 1,500 Meters

N

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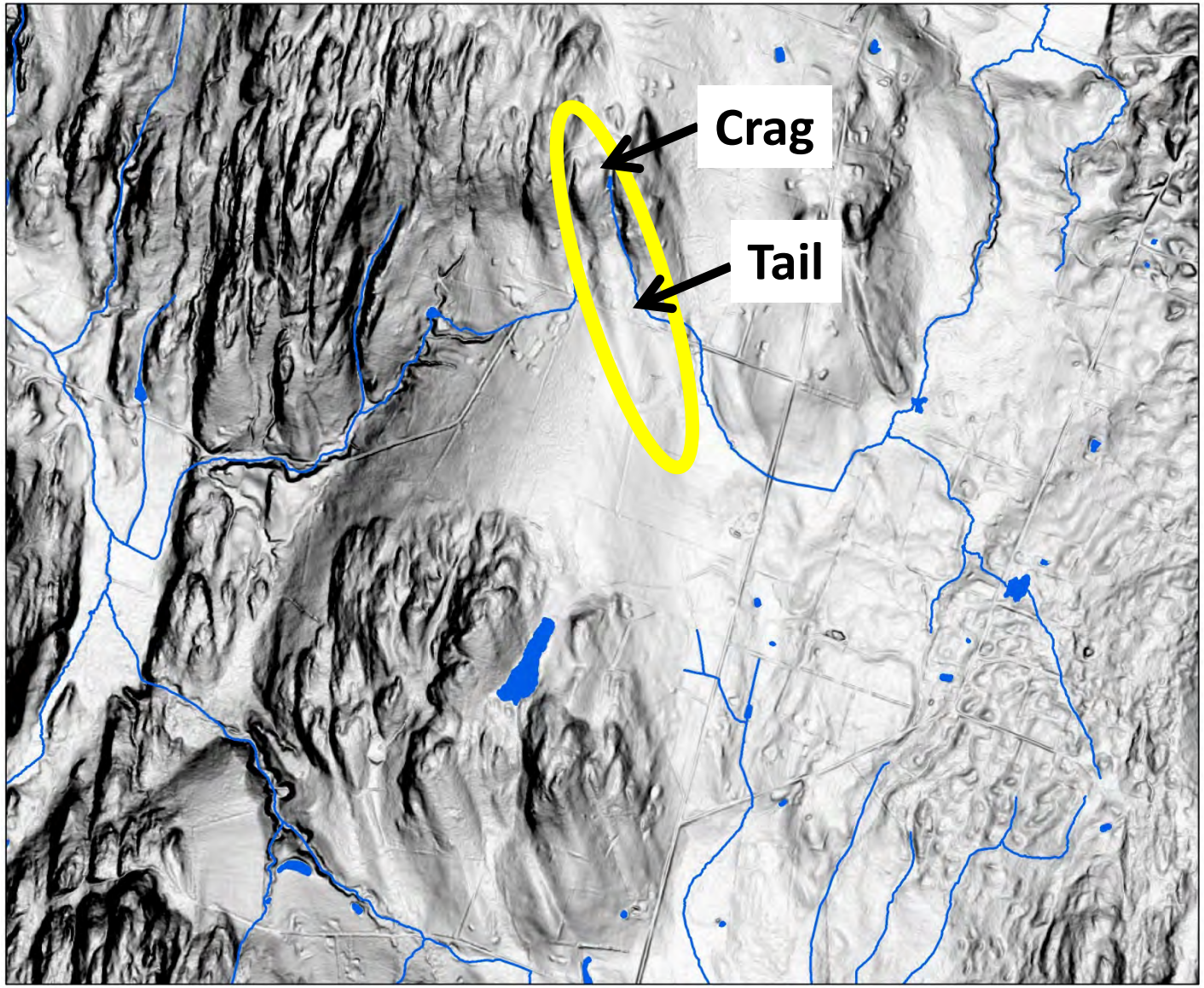
Crag and Tail Landforms in Williston, Chittenden County



Streams

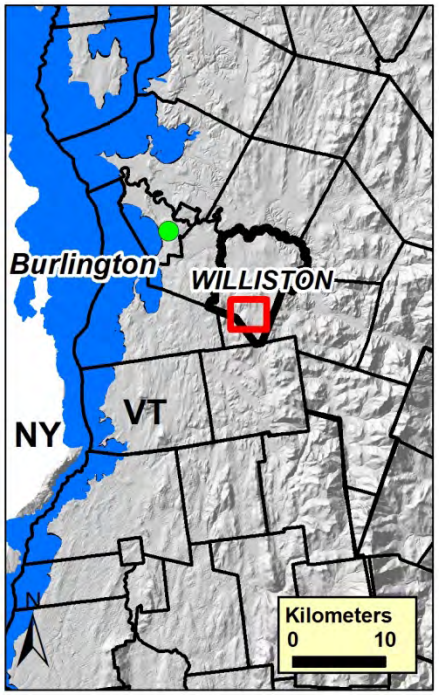
Water Bodies

Slope (Percent)

Value

High : 222.267

Low : 0.0100536



0 500 1,000 1,500 Meters

N

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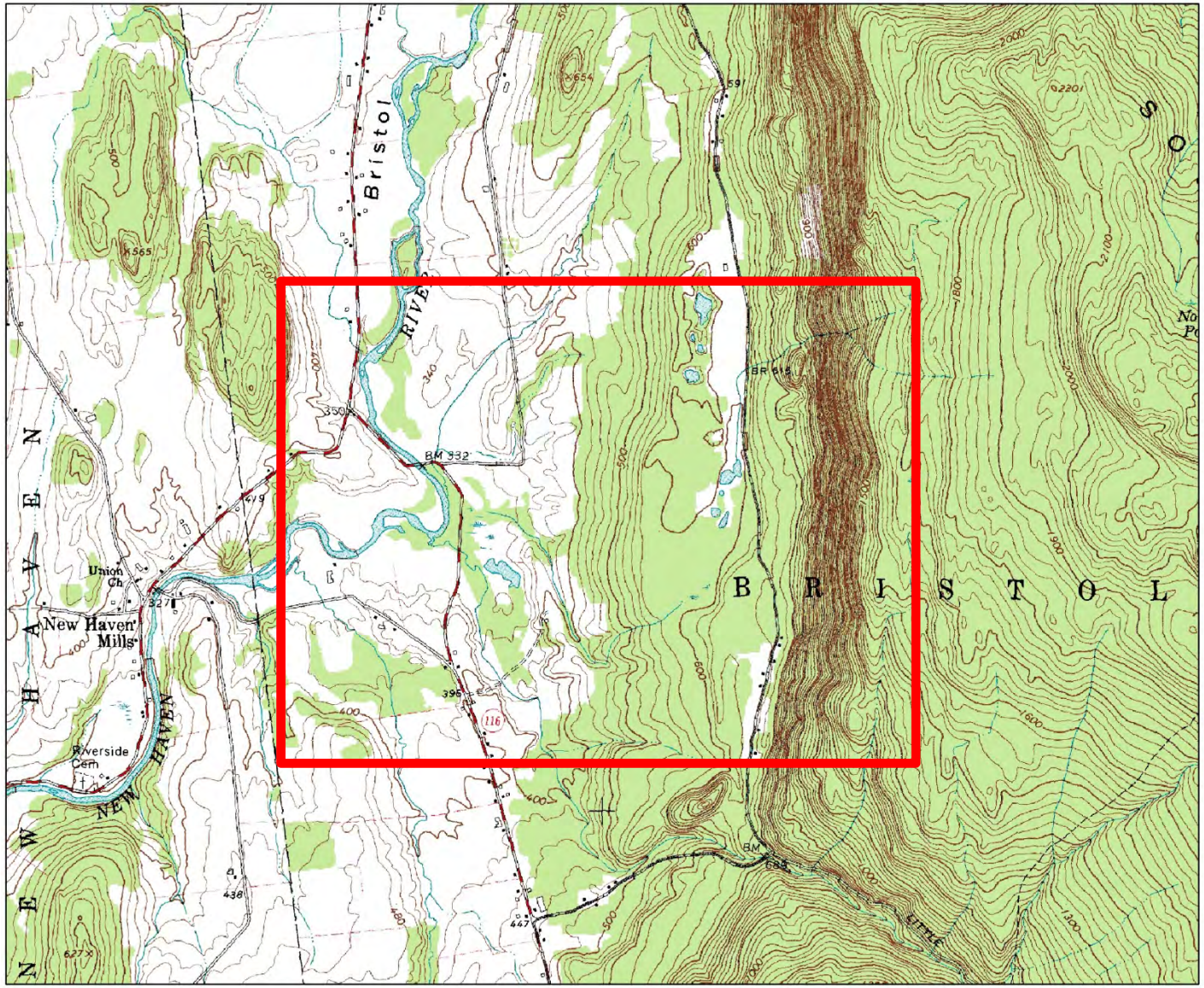
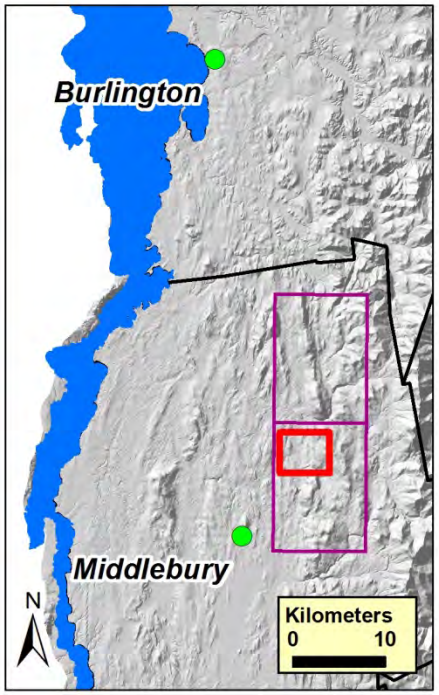
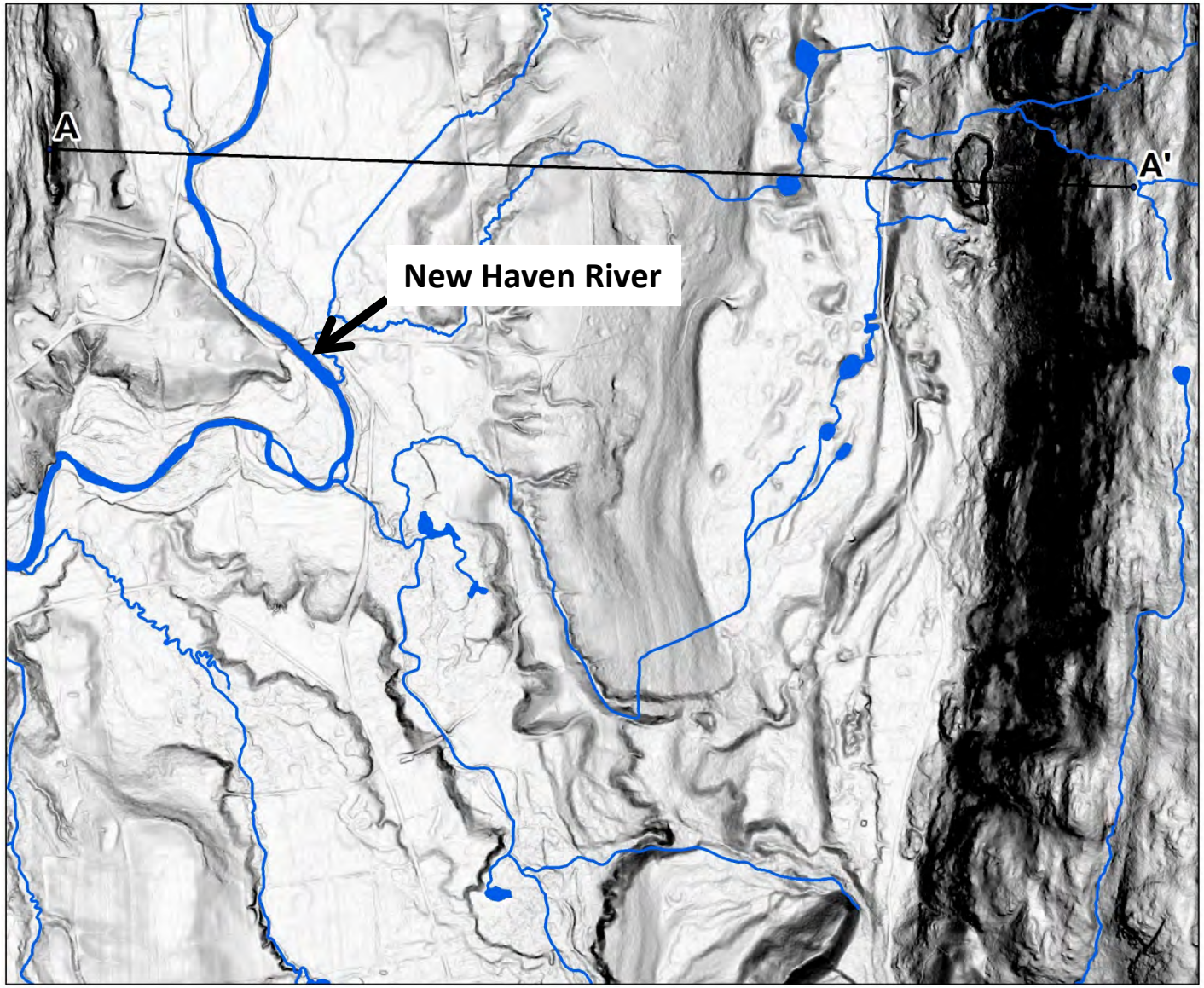
Lower Notch Road Kame Terrace in Bristol, South Mountain Quadrangle

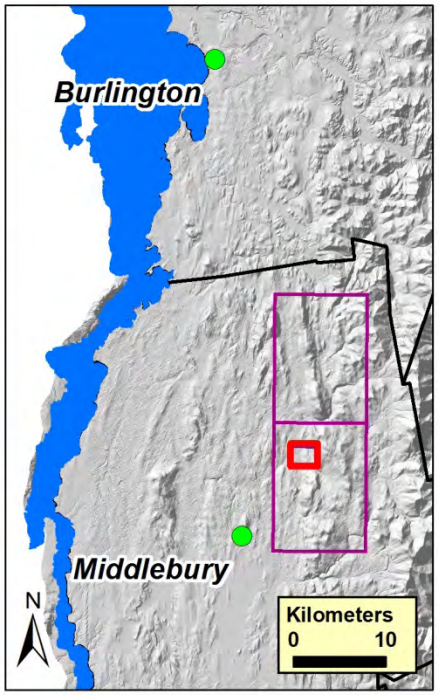




Lower Notch Road Kame Terrace in Bristol, South Mountain Quadrangle



LidarProfileLines
Streams
Water Bodies
Slope (Percent)
High
Low



0 500 1,000 Meters

N

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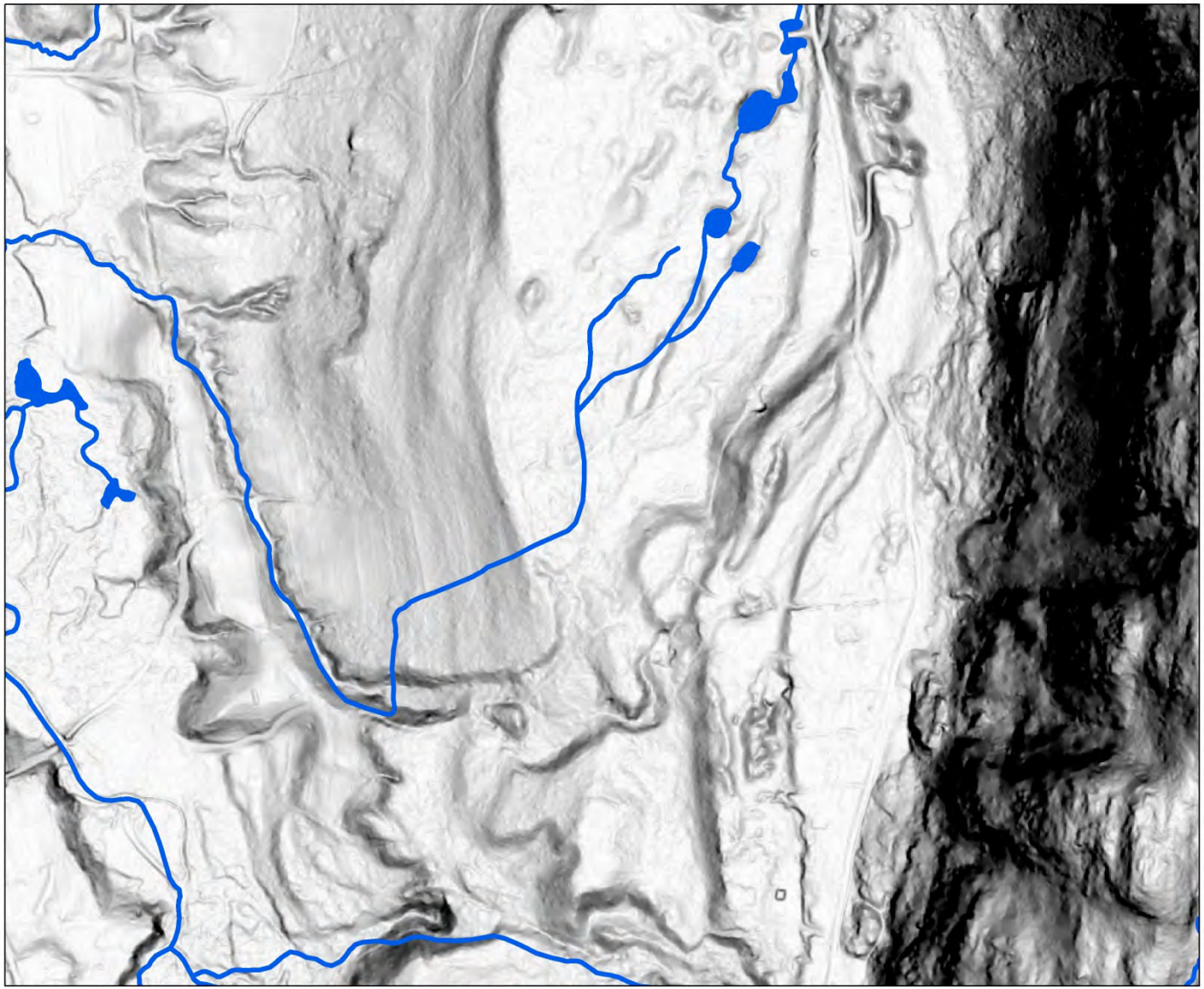
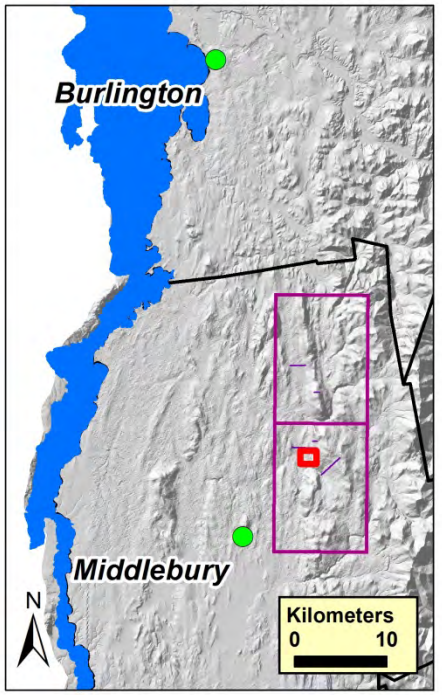
Lower Notch Road Kame Terrace in Bristol, South Mountain Quadrangle



LidarProfileLines
Streams
Water Bodies
Slope (Percent)
High
Low



0 500 Meters

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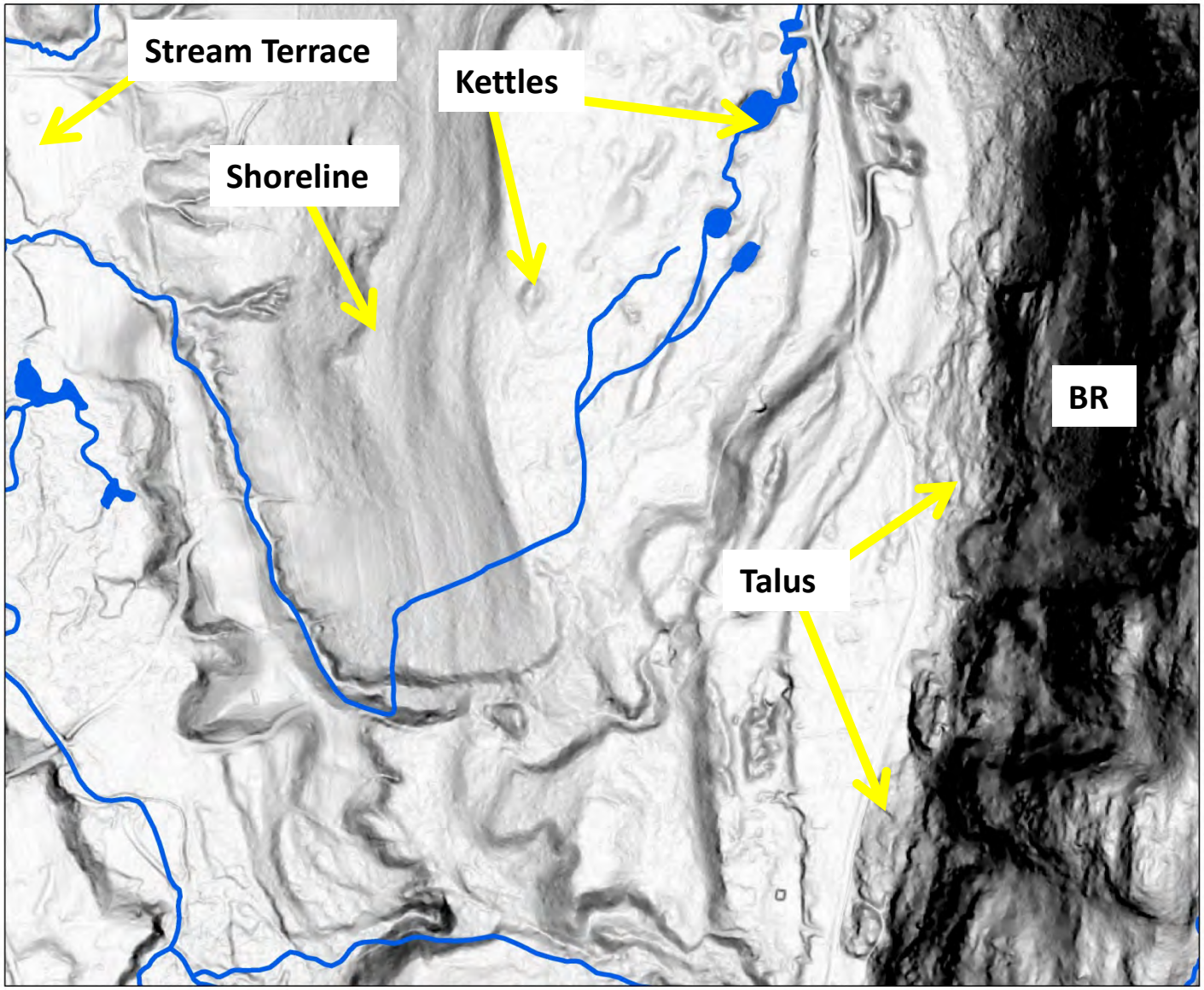
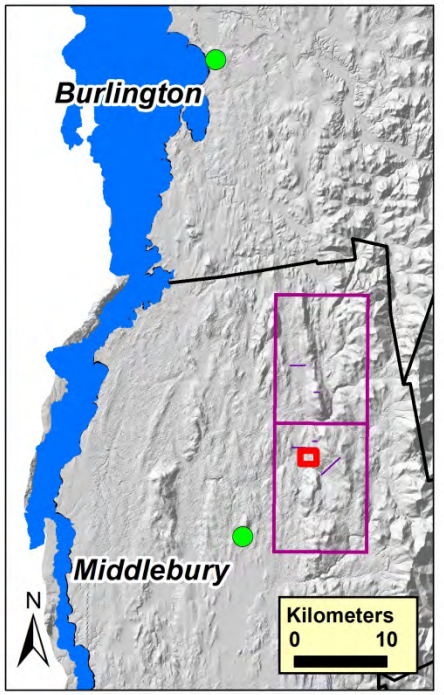
Lower Notch Road Kame Terrace in Bristol, South Mountain Quadrangle



LidarProfileLines
Streams
Water Bodies
Slope (Percent)
High
Low



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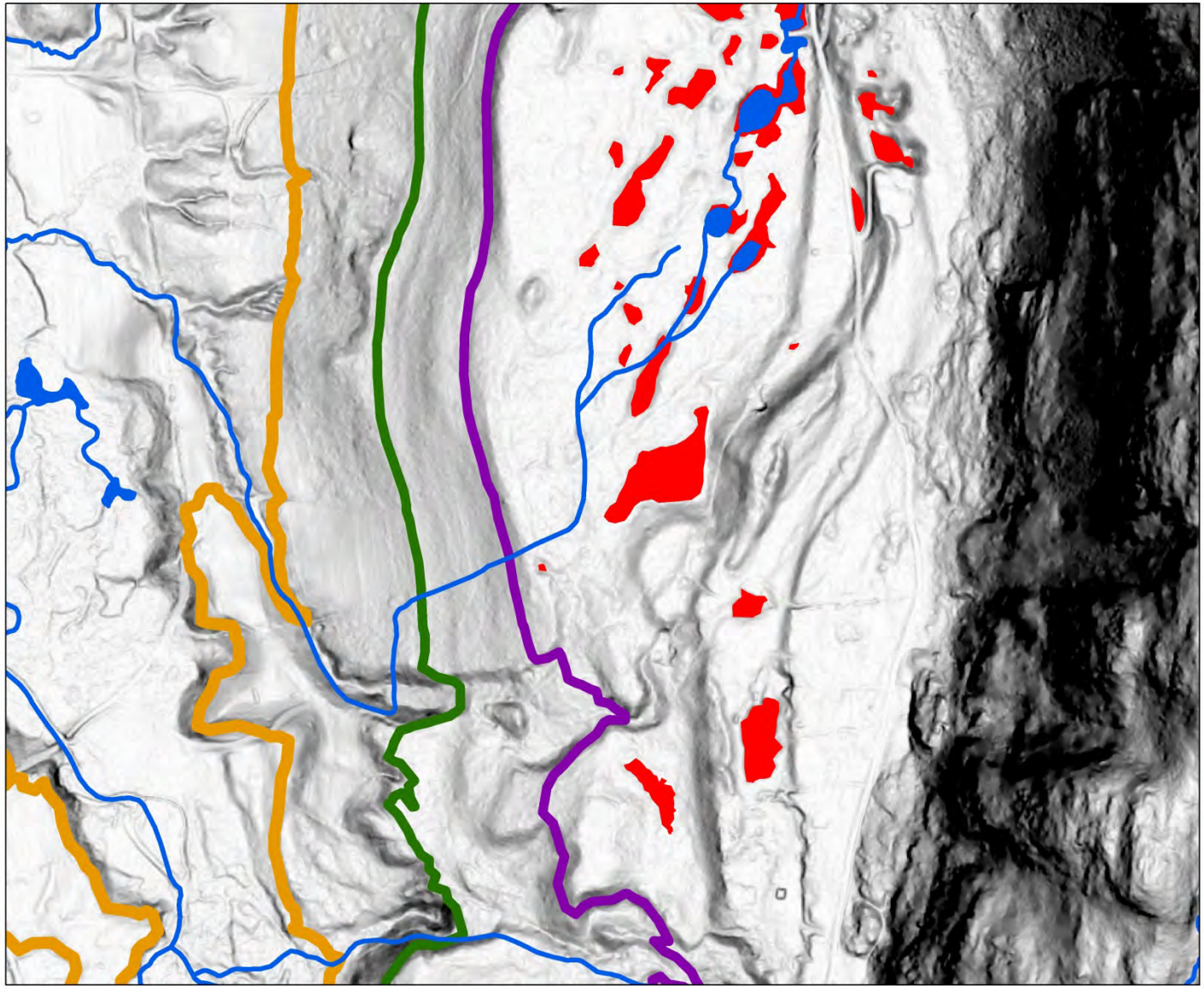
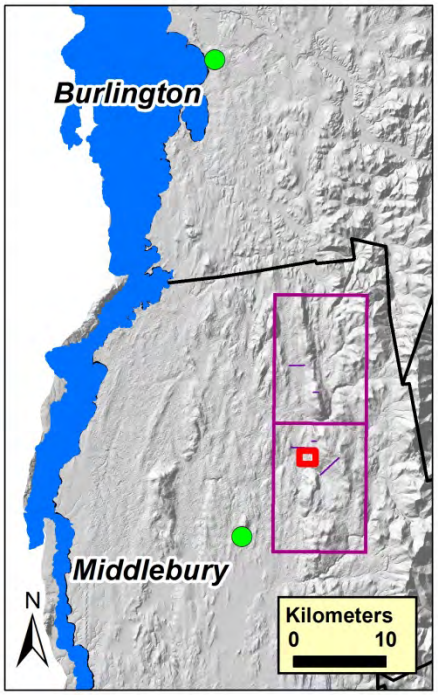


Coveville Shoreline
Upper Fort Ann Shoreline
Lower Fort Ann Shoreline
kettleholes
LidarProfileLines
Streams
Water Bodies
Slope (Percent)



0 500 Meters

N

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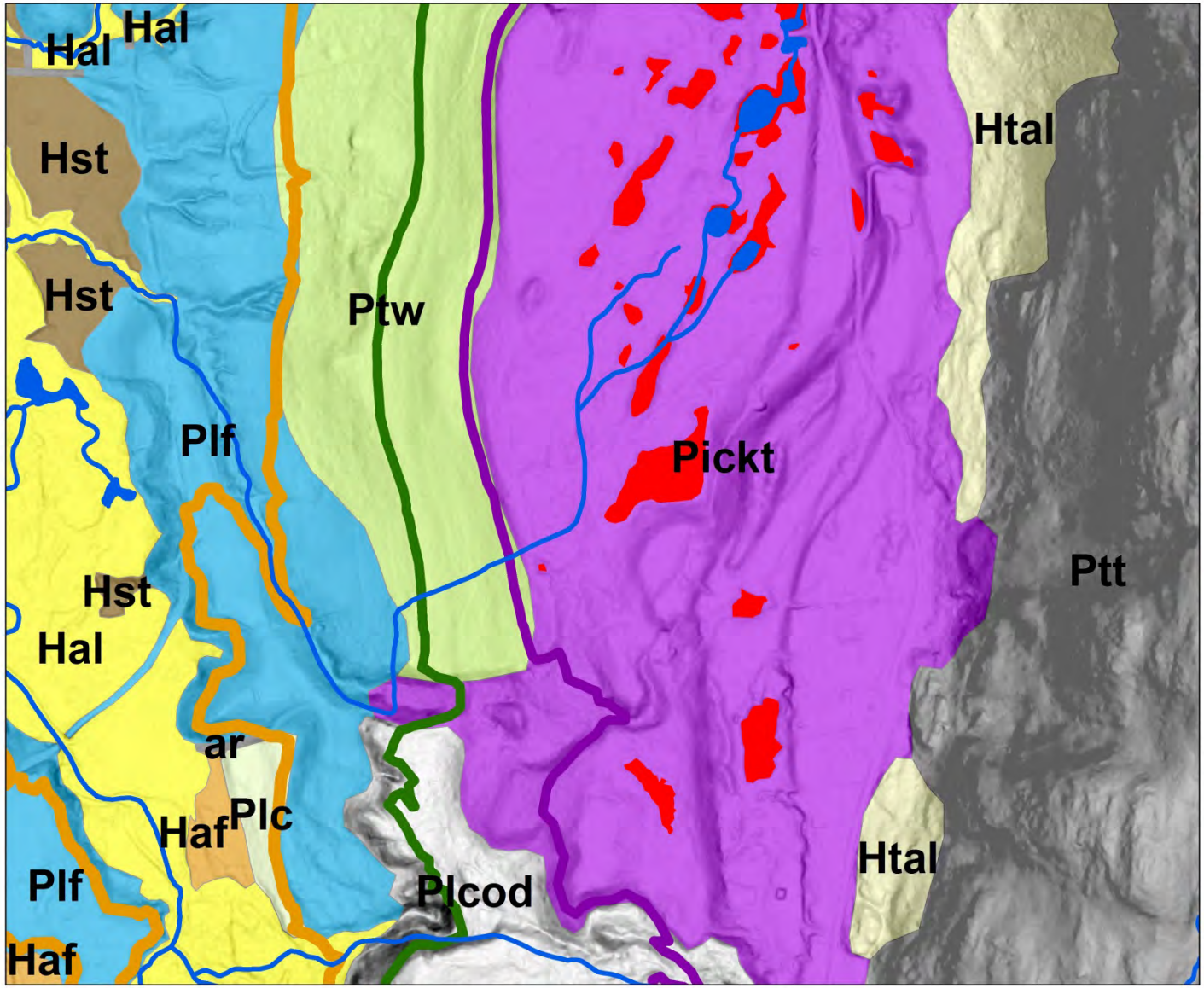
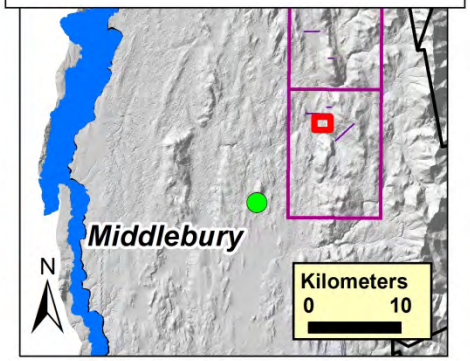
Lower Notch Road Kame Terrace



Surficial Units
- ar -- artificial fill
- gf -- graded or filled
- Haf -- alluvial fan
- Hal -- alluvium
- Hst -- stream terrace
- Htal -- talus
- Pickt -- ice contact, kame terrace
- Plc -- lacustrine, coarse
- Plf -- lacustrine, fine
- Plu -- lacustrine, undivided
- Ptw -- till , washed
- Pt -- till
- Ptt -- till, thin
- rk -- rock
- Coveville Shoreline
- Upper Fort Ann Shoreline
- Lower Fort Ann Shoreline
- kettleholes
- LidarProfileLines
- Streams
- Water Bodies

Slope (Percent)



0 500 Meters

N

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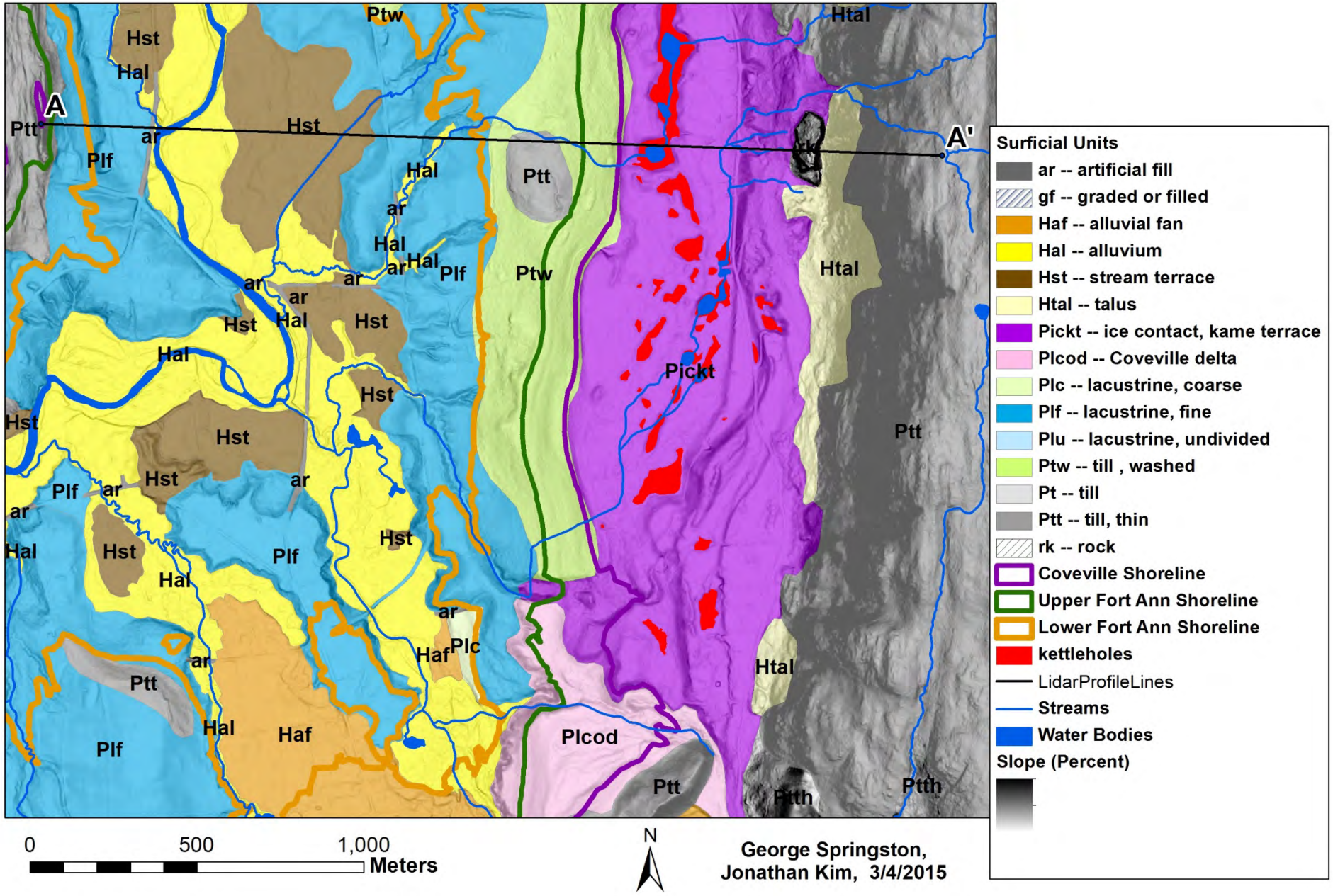
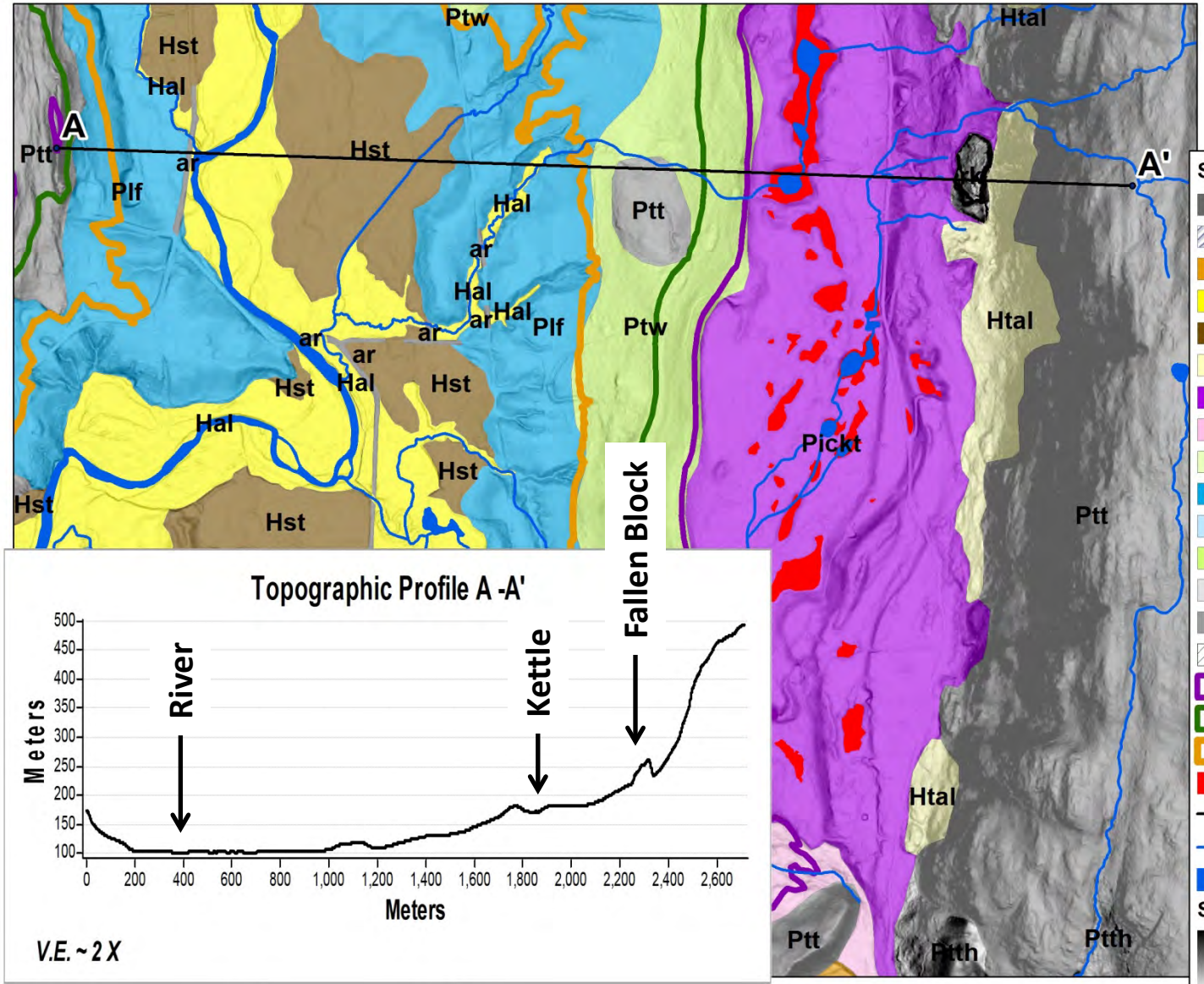
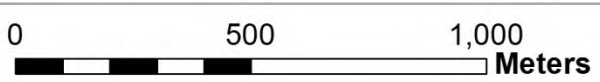
Lower Notch Road Kame Terrace in Bristol, South Mountain Quadrangle



Lower Notch Road Kame Terrace in Bristol, South Mountain Quadrangle





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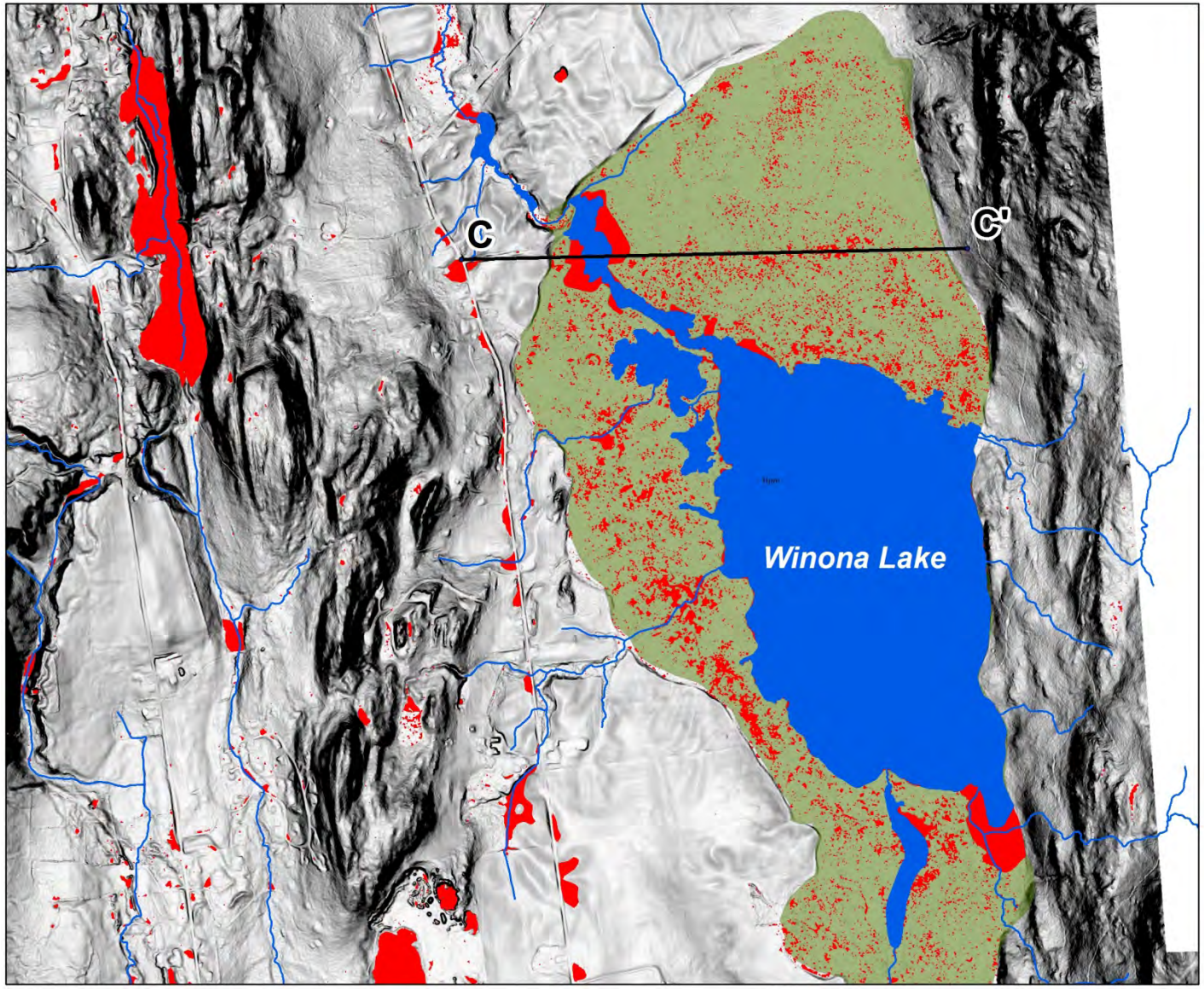
- Coveville Shoreline
- Upper Fort Ann Shoreline
- Lower Fort Ann Shoreline
- kettleholes
- LidarProfileLines
- Streams
- Water Bodies

Slope (Percent)

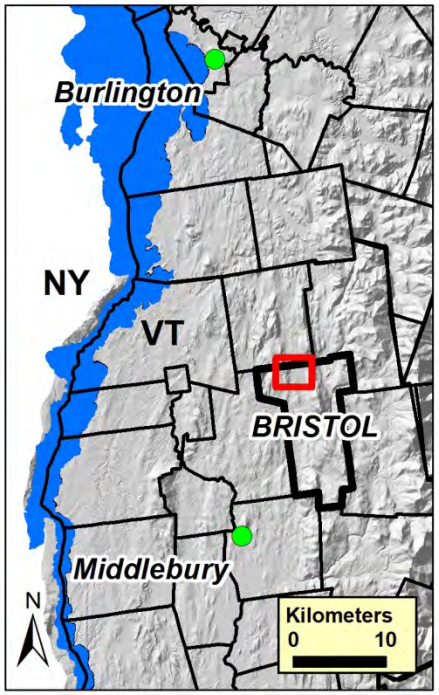
Hummocky Topography in a Peatland at Winona Lake, Bristol



Profile
Depressions
Peatland
Streams
Water Bodies

Slope (Percent)

High
Low



0 500 1,000 1,500 Meters

N

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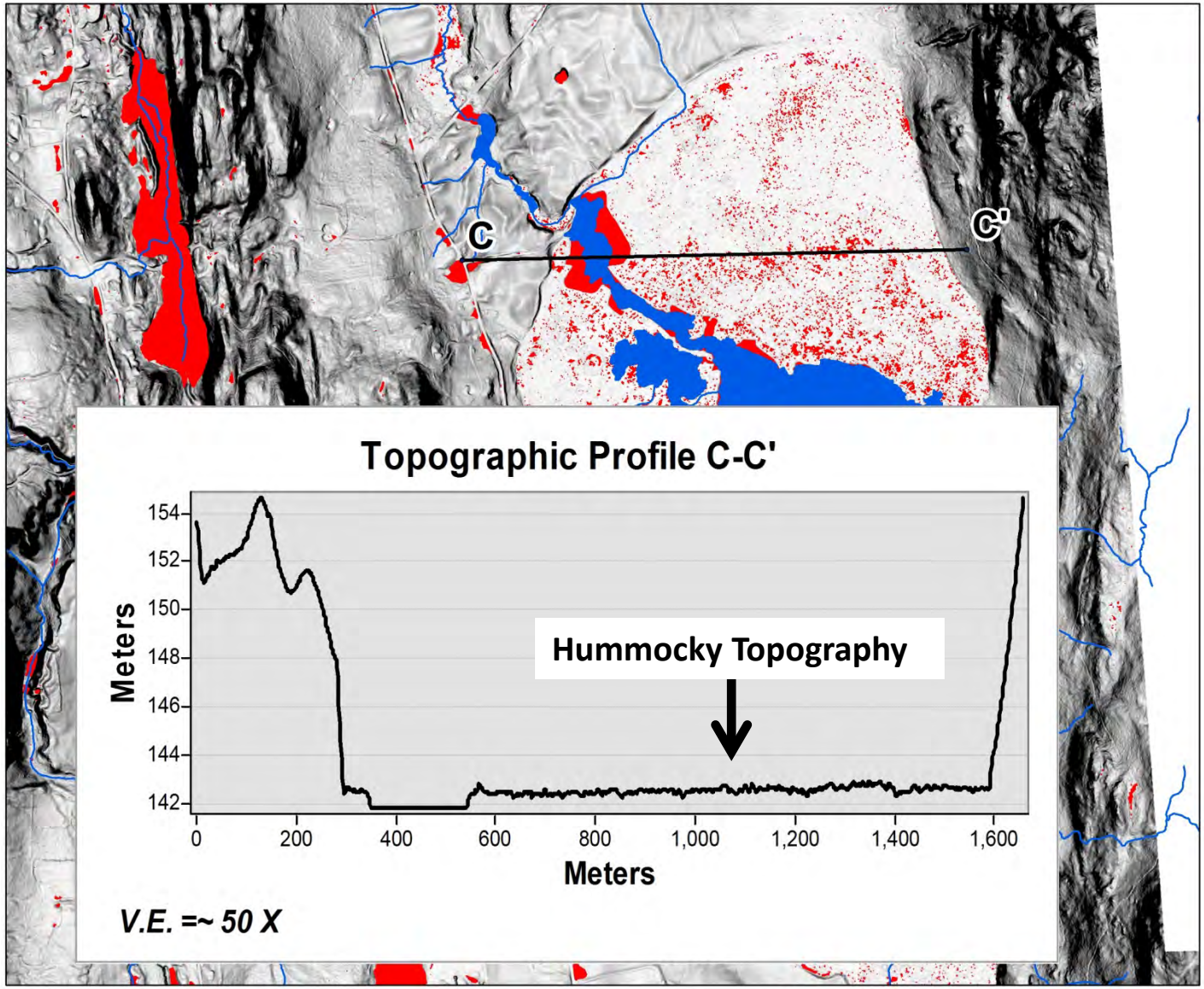
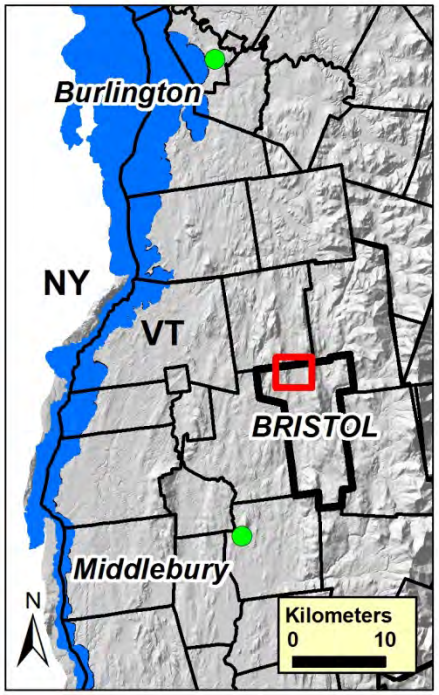
Profile Across Peatland



Profile
Depressions
Streams
Water Bodies
Slope (Percent)
High
Low



0 500 1,000 1,500 Meters

N

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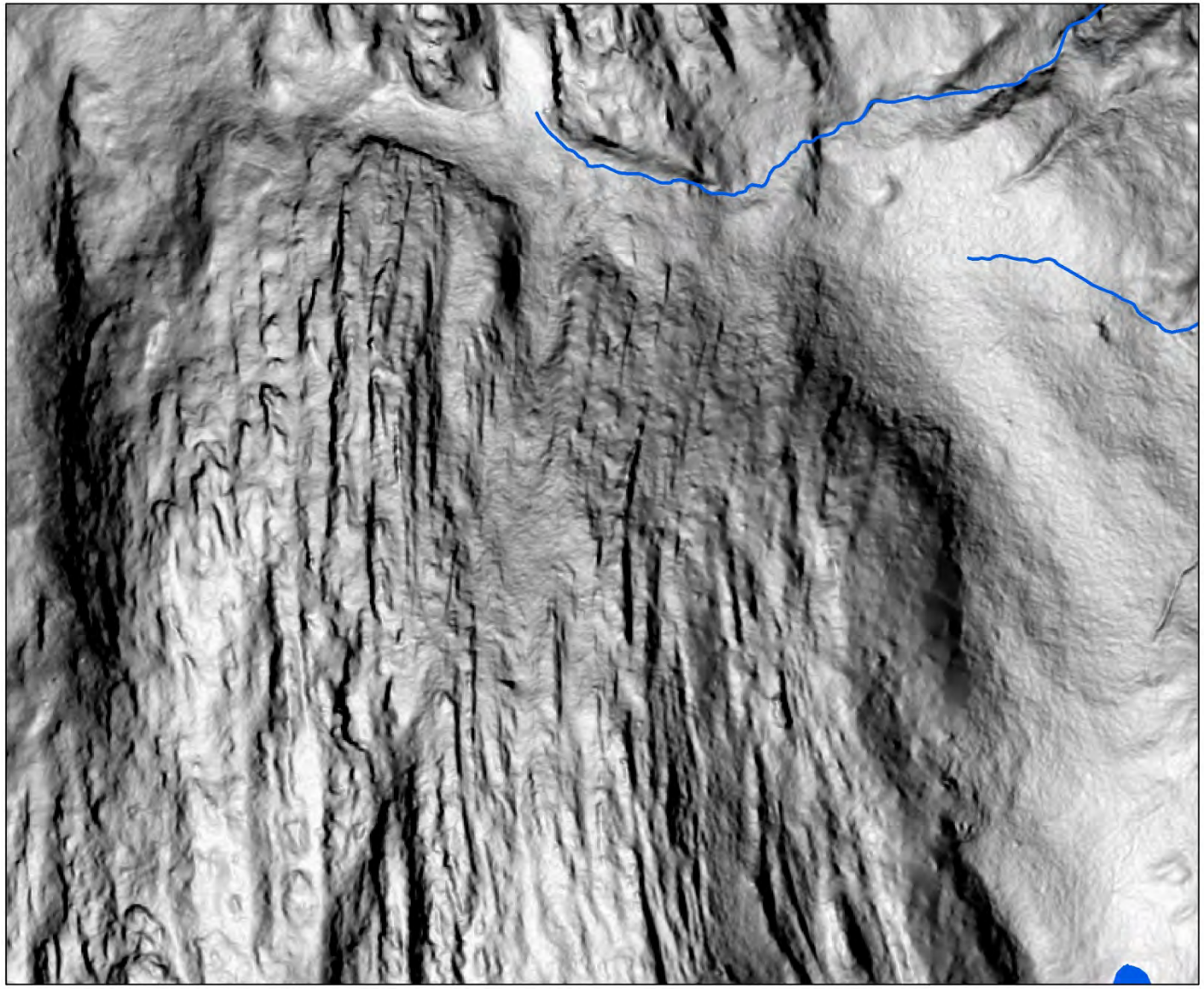
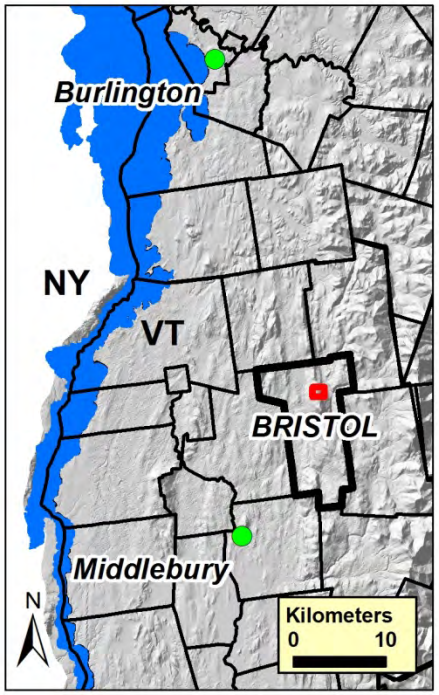
Jonathan Kim, 3/4/2015

Brittle and Ductile Structures in the massive quartzites of the Lower Cambrian Cheshire Formation on Hogback Mountain, Bristol.



Streams
Water Bodies
Slope (Percent)
High
Low



0 500 Meters

N

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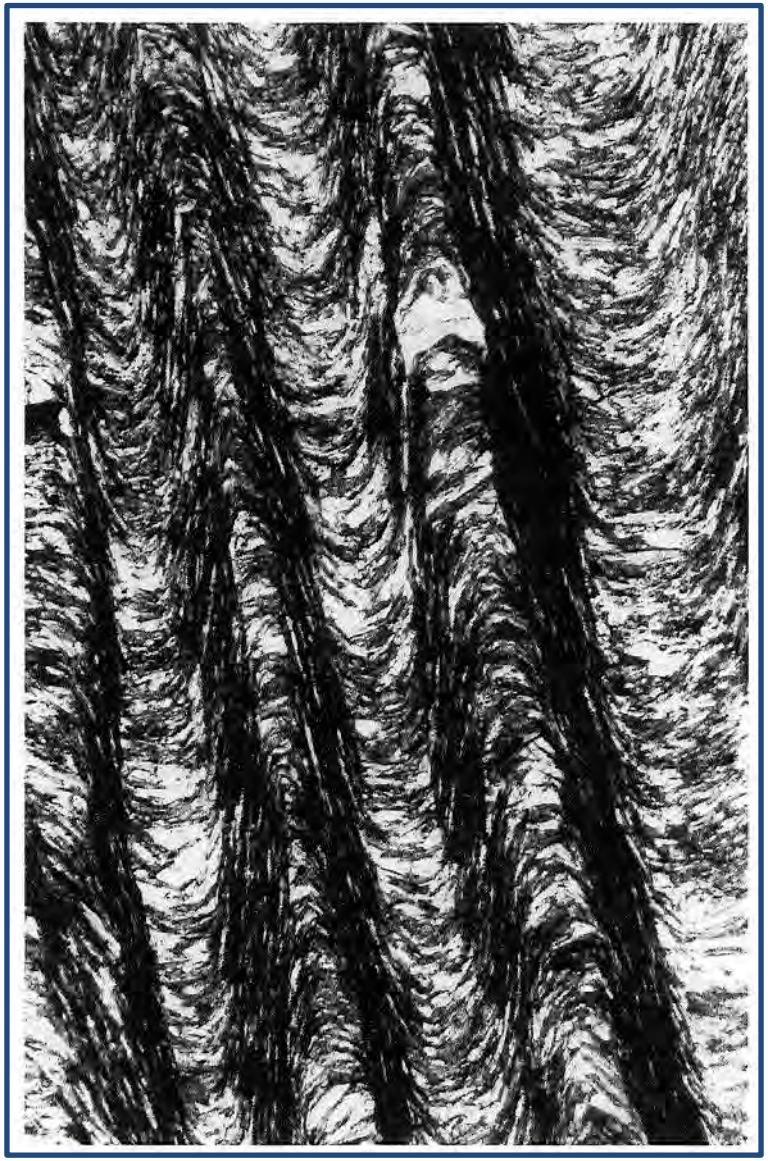
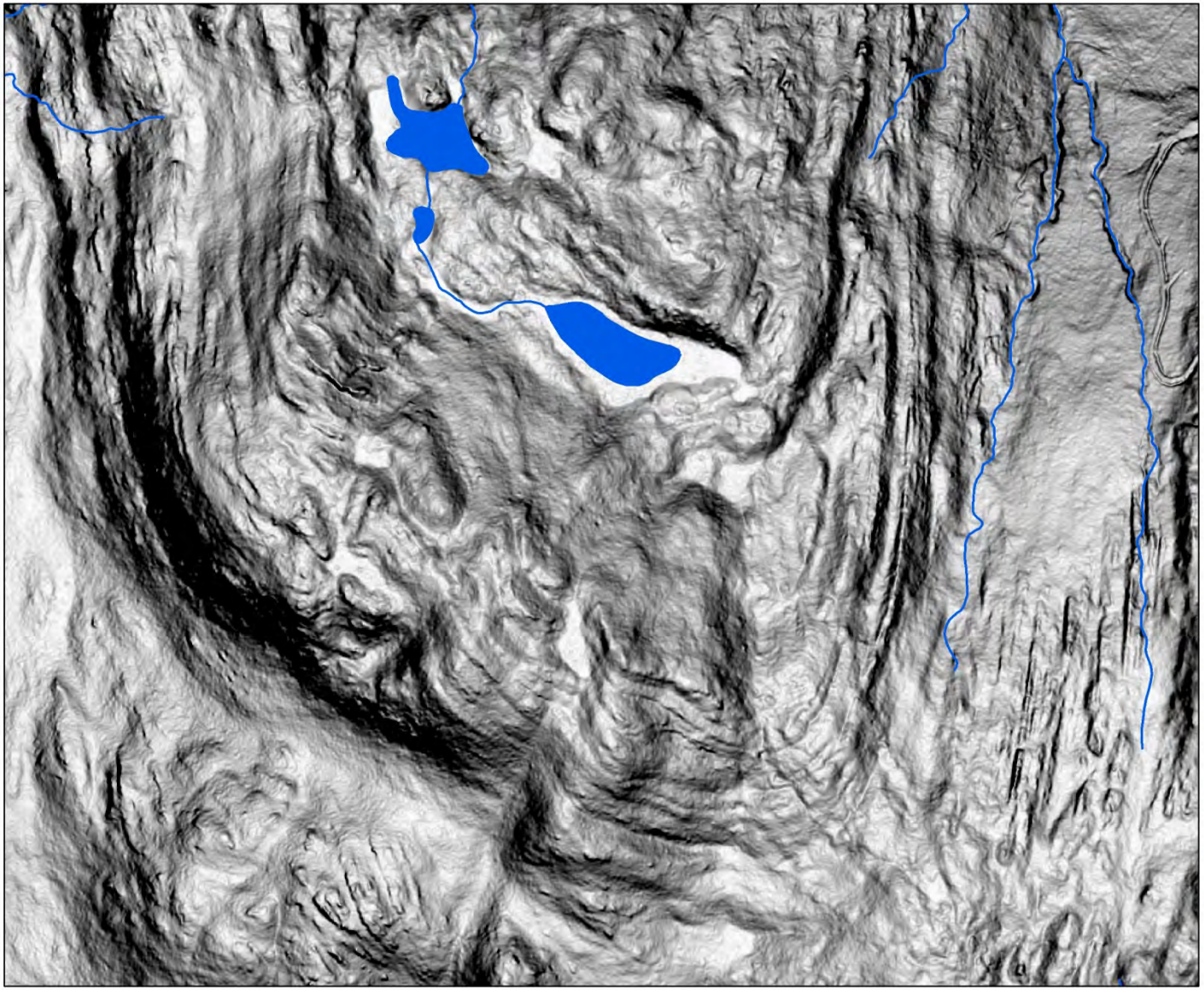
Cleavage and “megalithons” (left)

Cleavage and microlithons (right)

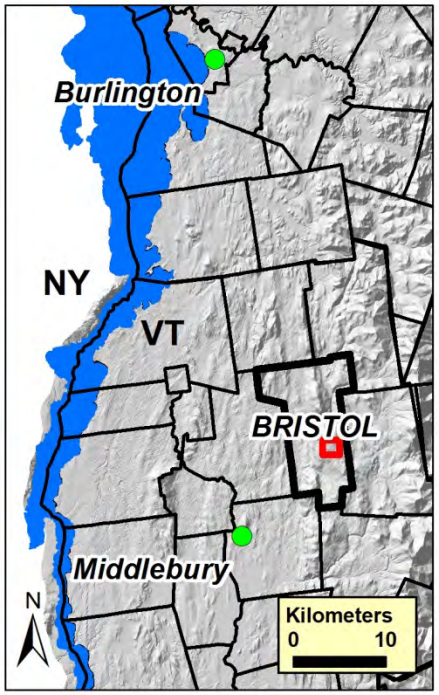


From Passchier and Trouw, 2005, Figure 4.12.
Field of view is about 2.5 mm across.

Brittle and Ductile Structures on South Mountain in Bristol



Streams
Water Bodies
Slope (Percent)
High
Low



0 500 Meters

N

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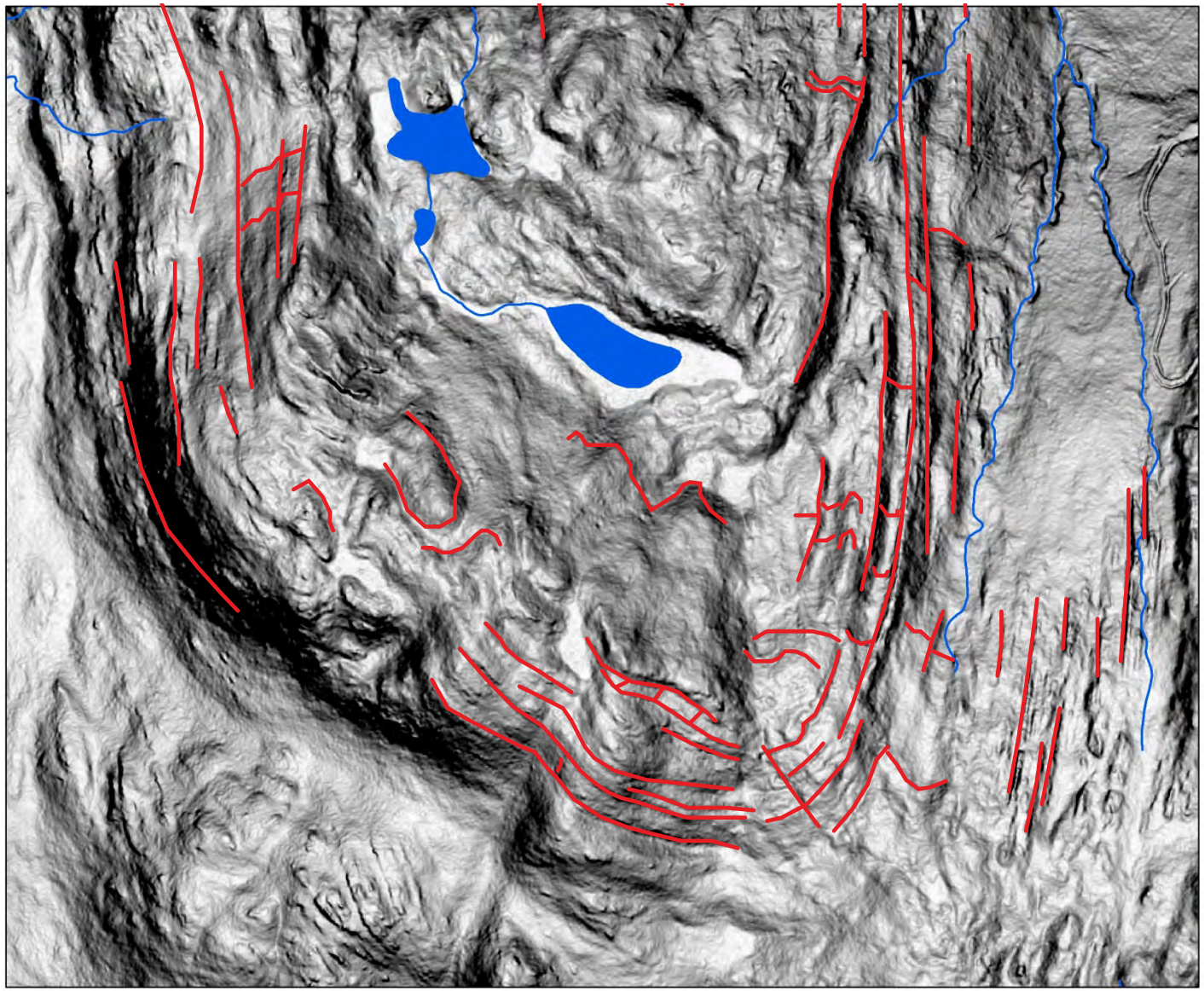
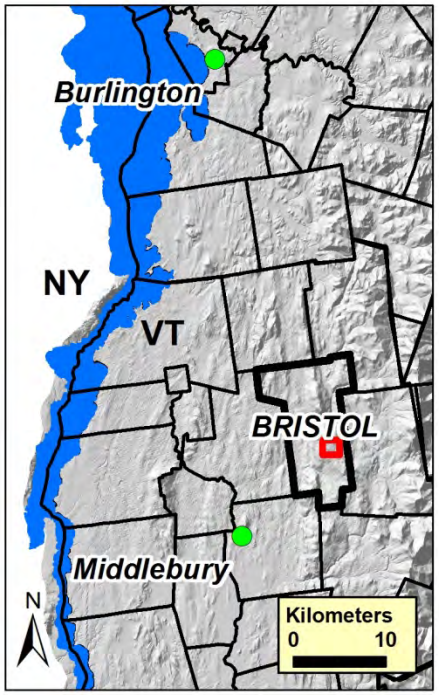
Brittle and Ductile Structures on South Mountain in Bristol



Streams
Water Bodies
Slope (Percent)
High
Low

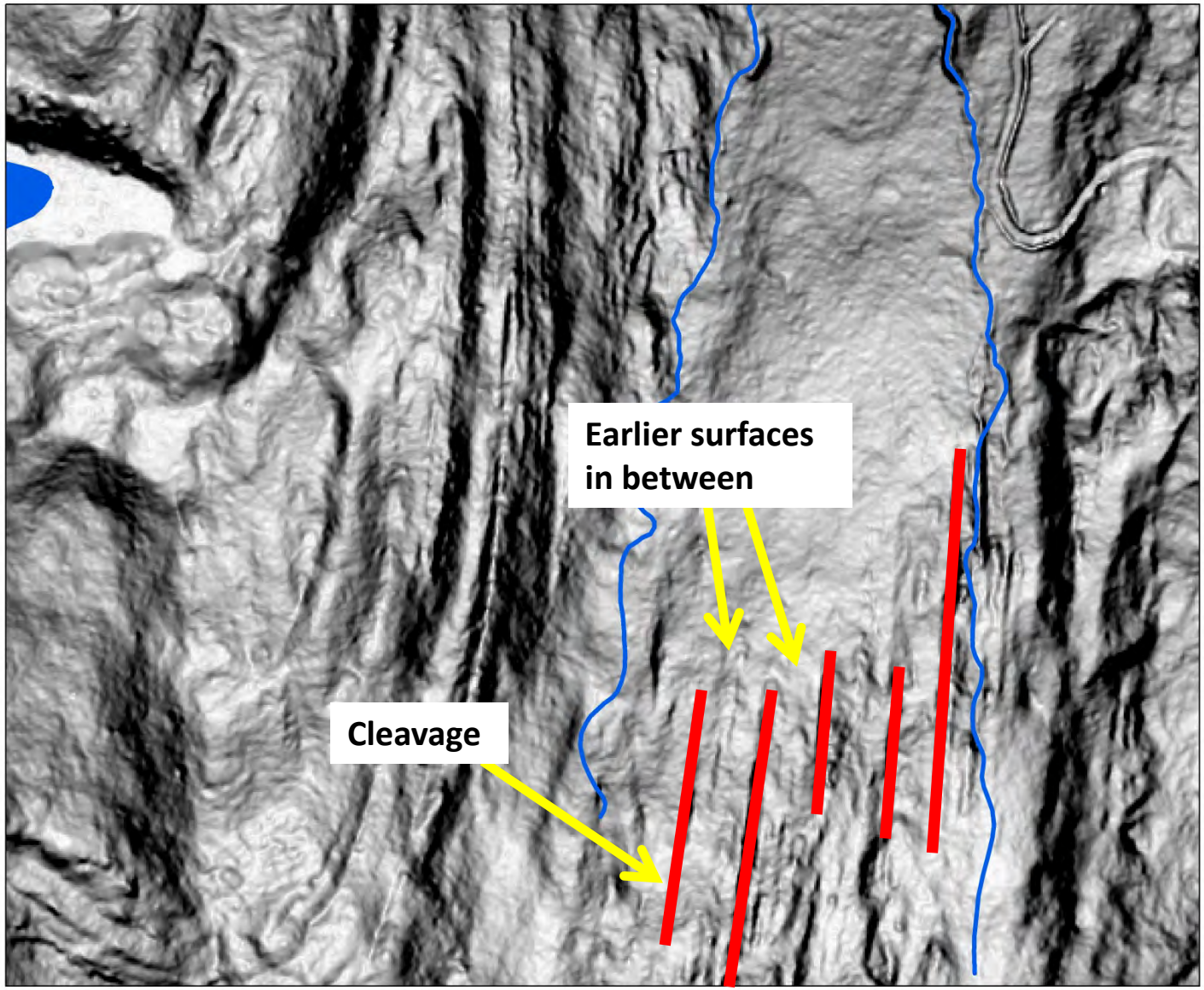


0 500 Meters

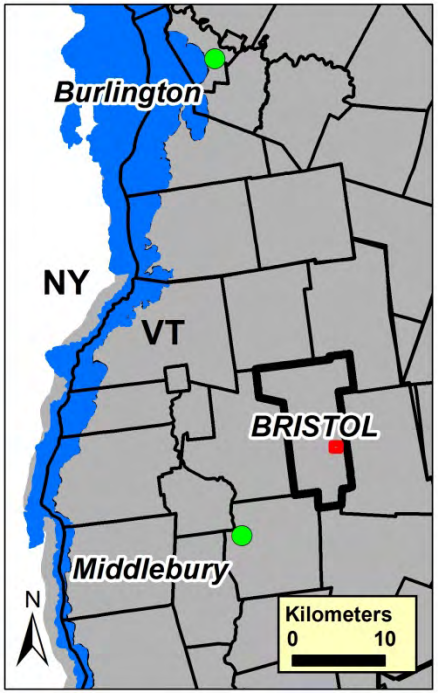
N

George Springston,
Jonathan Kim, 3/4/2015

Brittle and Ductile Structures on South Mountain in Bristol



Streams
Water Bodies
Slope (Percent)
High
Low



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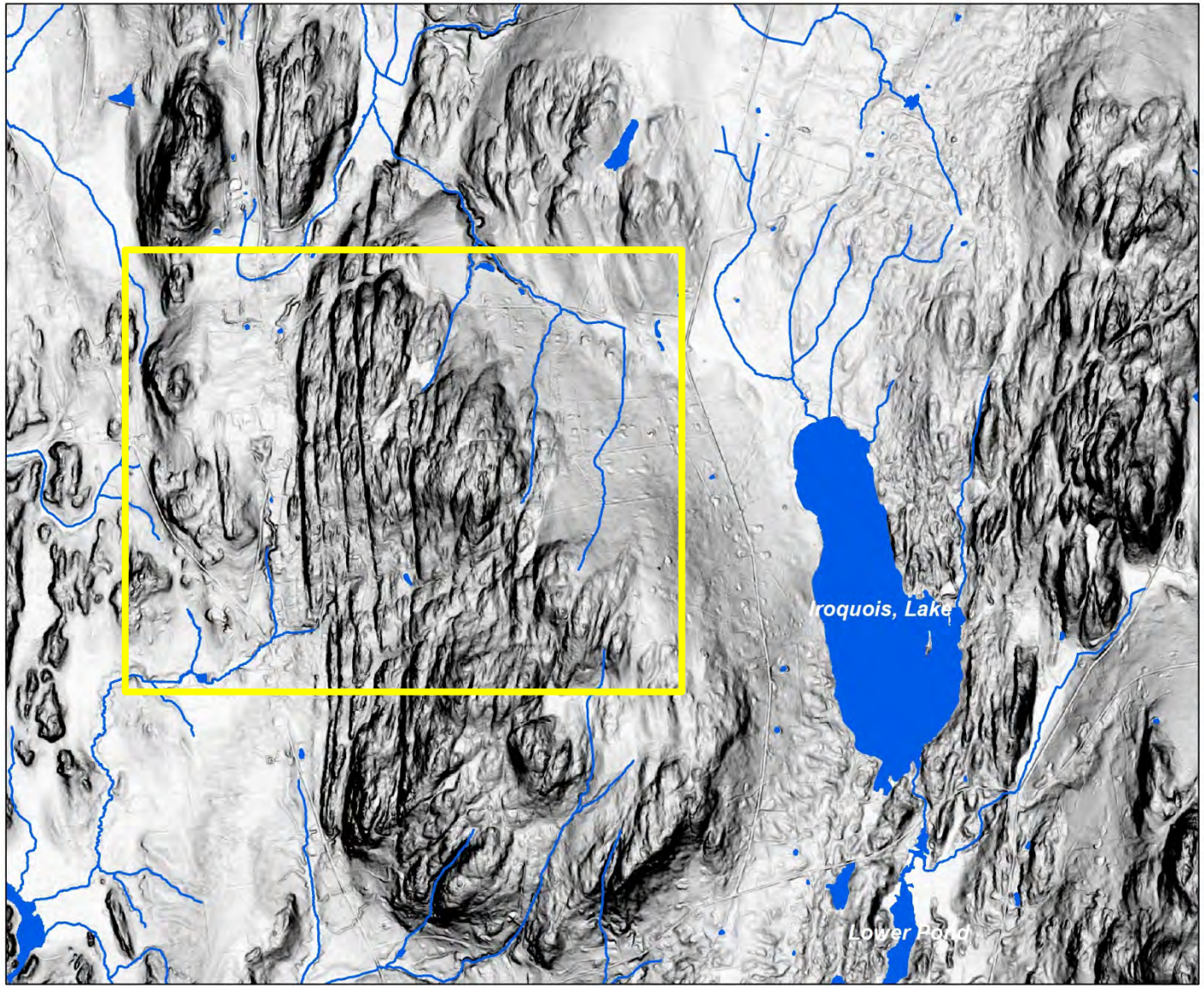
Lineaments in the Cambrian – Neoproterozoic Fairfield Pond Formation (Phyllite and Phyllitic Quartzite) in southern Williston and St. George



Streams

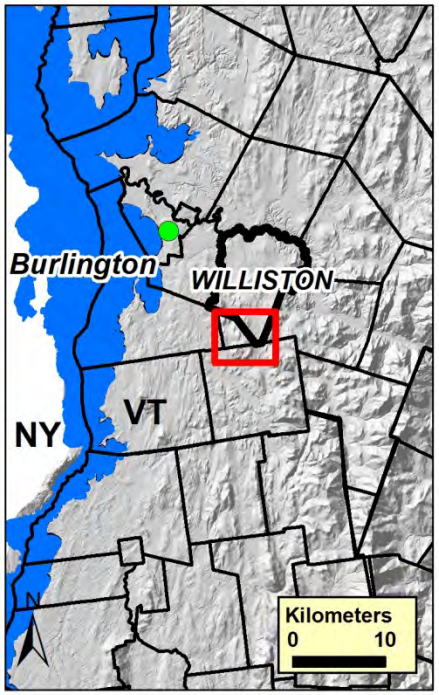
Water Bodies

Slope (Percent)

Value

High : 217.47

Low : 0



0 500 1,000 1,500 2,000 2,500 3,000 Meters

N

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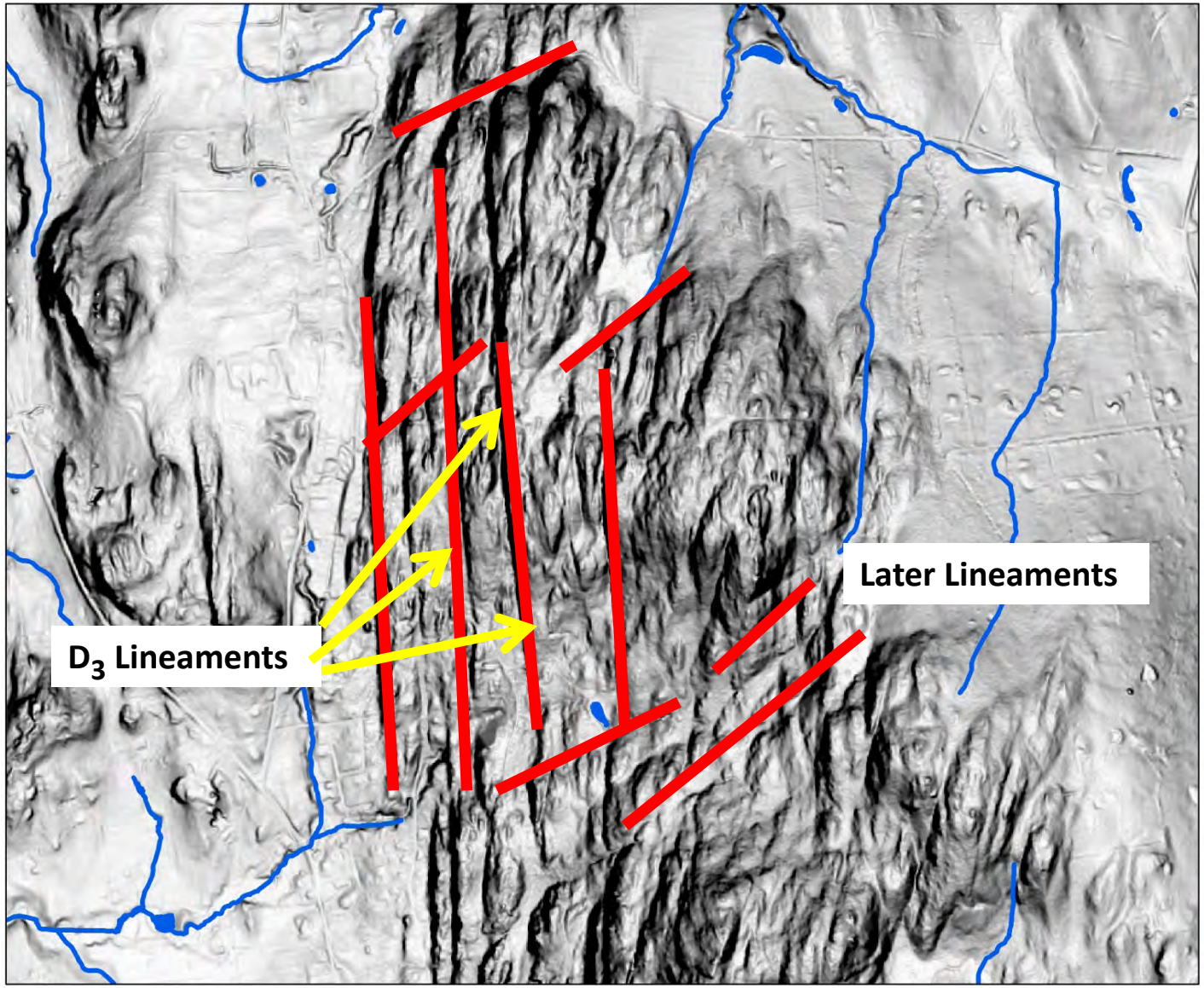
Jonathan Kim, 3/11/2015

Lineaments in the Cambrian – Neoproterozoic Fairfield Pond Formation (Phyllite and Phyllitic Quartzite) in southern Williston and St. George



Streams

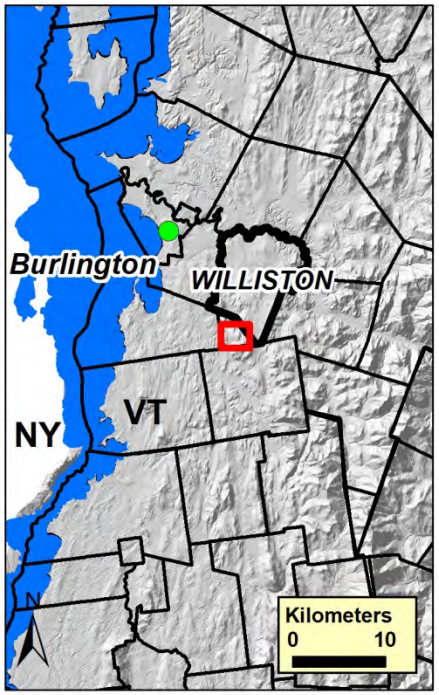
Water Bodies

Slope (Percent)

Value

High : 209.557

Low : 0.00524402



0 500 1,000 1,500 Meters

N

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Jonathan Kim, 3/11/2015

Analysis of Map-scale Structures in Williston: D_3 Folds in the Phyllites and Phyllitic Quartzites of the Fairfield Pond Formation

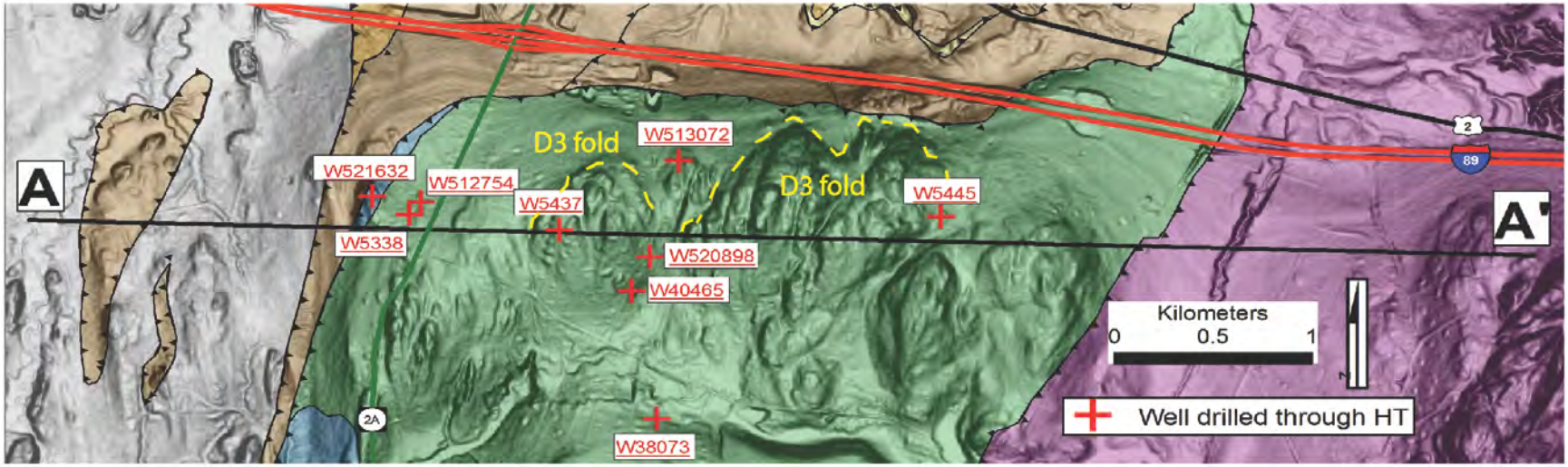


Figure 8A

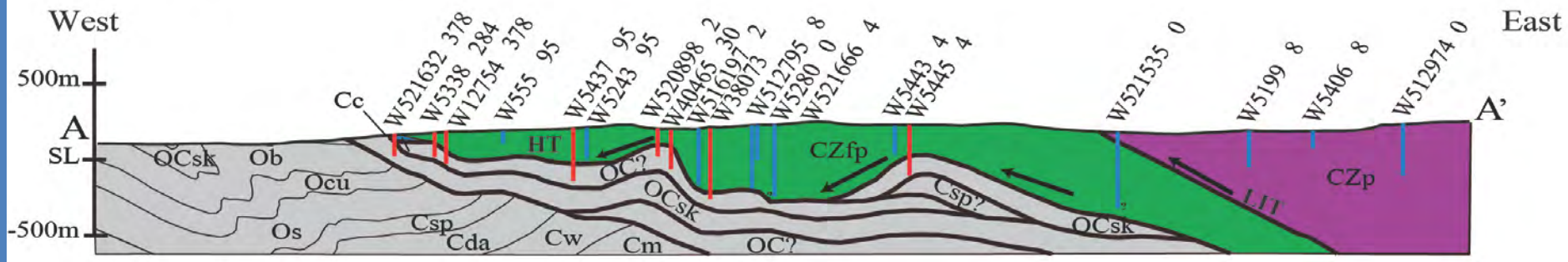


Figure 8B

Lidar slope map was used to help map dome-and-basin fold patterns on the upper plate of the Hinesburg Thrust in the Williston area.

From Kim, J., Ryan, P., Klepeis, K., Gleeson, T., North, K., Bean, J., Davis, L., and Filoon, J., 2014, Tectonic evolution of a Paleozoic thrust fault influences the hydrogeology of a fractured rock aquifer, northeastern Appalachian foreland: Geofluids, doi: 10.1111/gfl.12076.

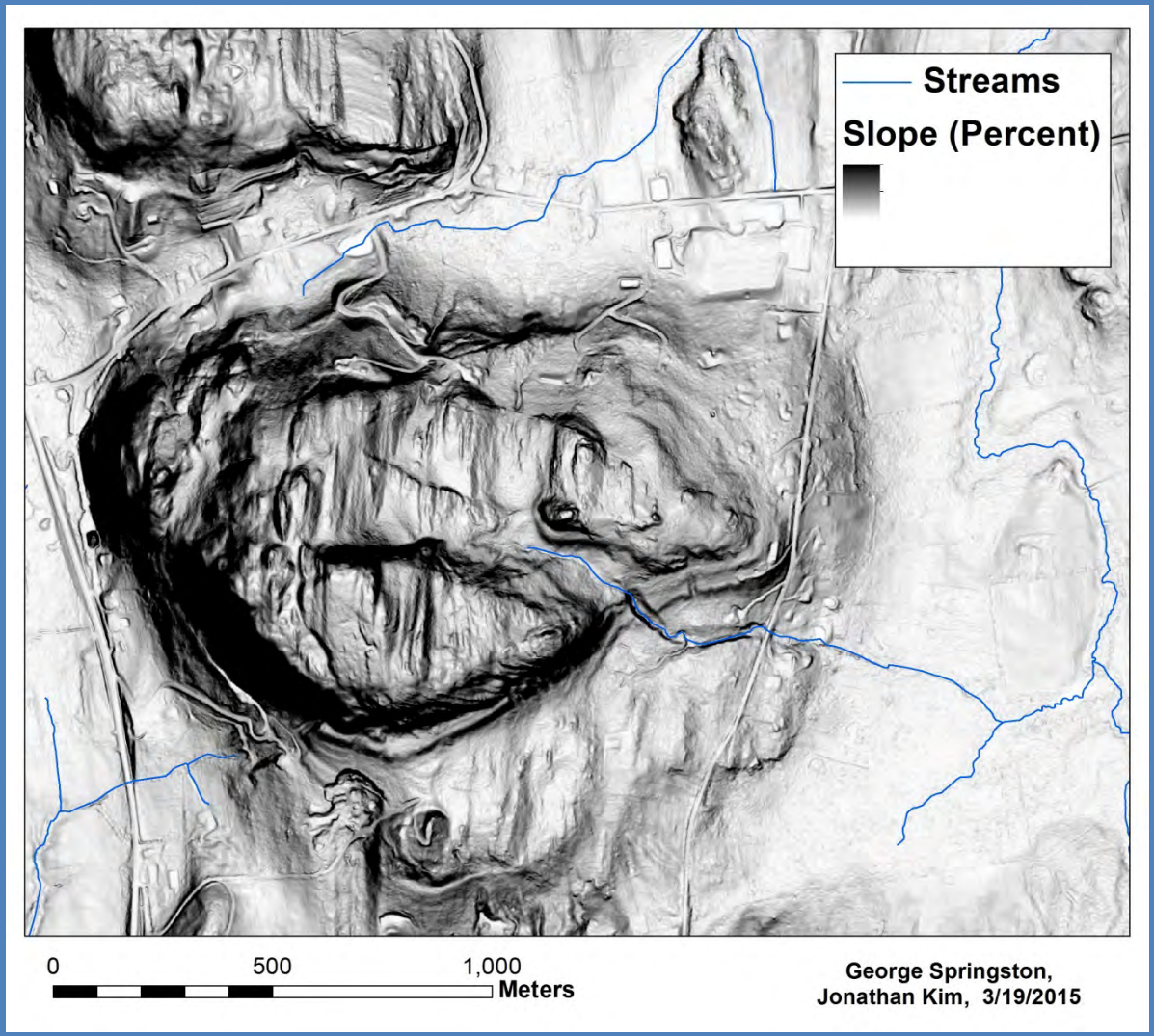
Summary

1. Lidar facilitates identification and mapping of a wide variety of surficial and bedrock features.

2. Slope maps are the single most effective product for geologic interpretation

3. It is most powerful when used in conjunction with the actual field work so that subtle features can be targeted for field visits.

4. Lidar is a powerful tool for detailed structural analysis of both brittle and ductile features.

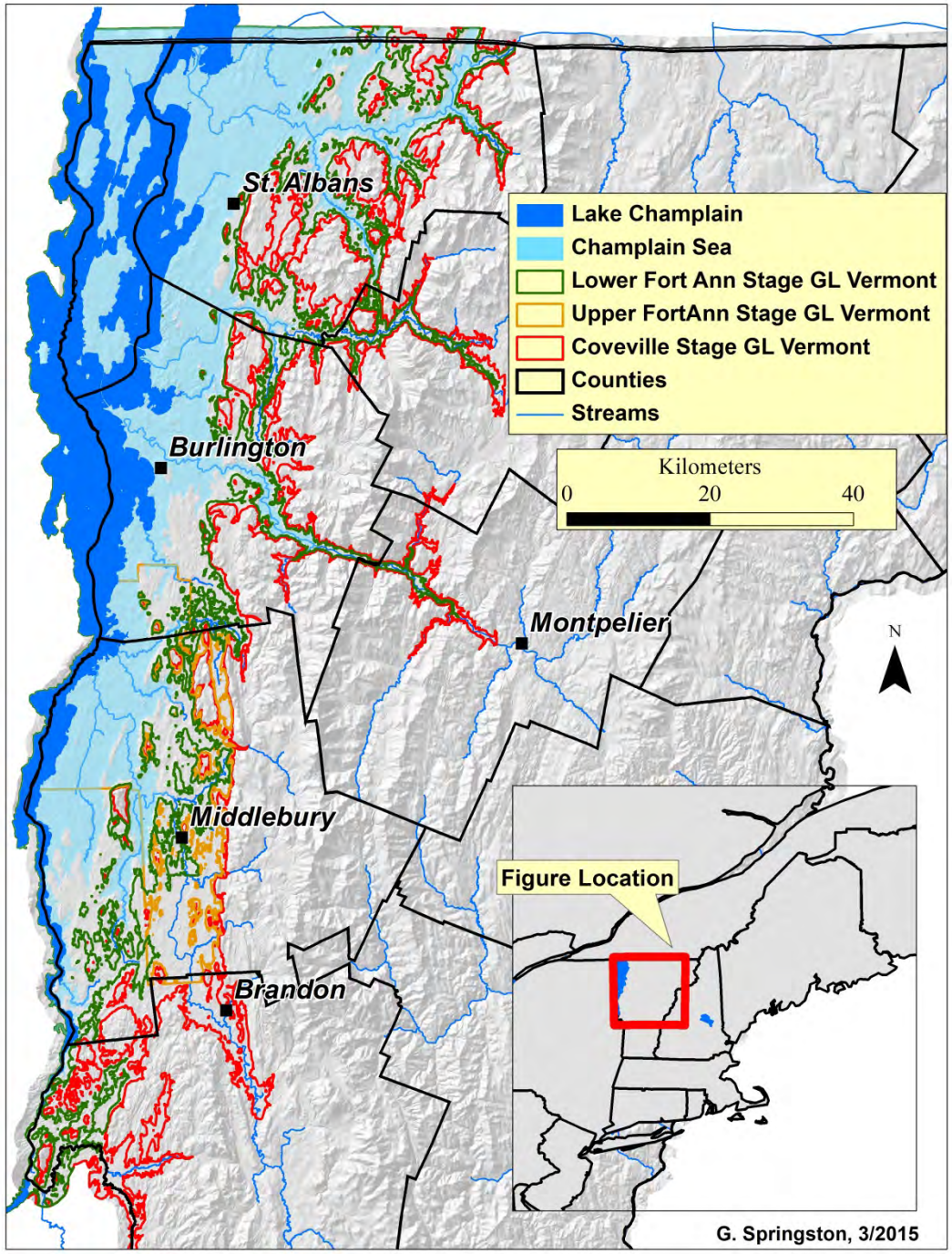


Summit of Pease Mountain, Charlotte

Future work:
Use lidar to refine glacial Lake Vermont and Champlain Sea shorelines.

Continue use of lidar for bedrock structural analysis.

Continue developing terrain analysis techniques using slope, curvature, roughness, and other parameters that can be derived from lidar DEMs.



Right: Late Glacial and Post-glacial shorelines in the Champlain Valley. The shorelines shown here rise ~0.7 to 1.0 m/km to the north due to isostatic uplift during the Holocene (Rayburn, 2004).

Acknowledgements

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Reference Cited:

Rayburn, J.A., 2004, Deglaciation of the Champlain Valley, New York and Vermont and its possible effects on North Atlantic climate change: Unpublished Ph.D. dissertation, Binghampton Univ., Binghampton, NY, 158p.

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