DIGITAL MAPPING TECHNIQUES 2018

The following was presented at DMT'18
(May 20-23, 2018 - University of Kentucky,
Lexington, KY)

The contents of this document are provisional

See Presentations and Proceedings
from the DMT Meetings (1997-2018)

http://ngmdb.usgs.gov/info/dmt/

Topographic Maps and LiDAR in Field Mapping and Research at the Geological Survey of Alabama

By Sandy Ebersole and Brian Cook
Geological Survey of Alabama
PO Box 869999
Tuscaloosa, AL 35486
Telephone: (205) 247-3613
Email: sebersole@gsa.state.al.us

While limitations and inaccuracies of 7.5' topographic maps can bring challenges to geologic mapping, LiDAR, high resolution elevation data, can help clarify some of these issues. With greater detail and accuracy, LiDAR allows clarification of elevation and surface (especially in areas of dense tree cover), identification of anthropogenic features, characterization of surficial geologic units, location of geologic hazards, generation of new contour base maps, and more. In this presentation, we combine examples of challenges in mapping and research projects at the Geological Survey of Alabama, and give examples of the LiDAR derivatives and methods we use to help address some of those challenges. Examples presented include techniques from geologic mapping (STATEMAP), geologic hazards, coastal, and environmental divisions.

REFERENCES

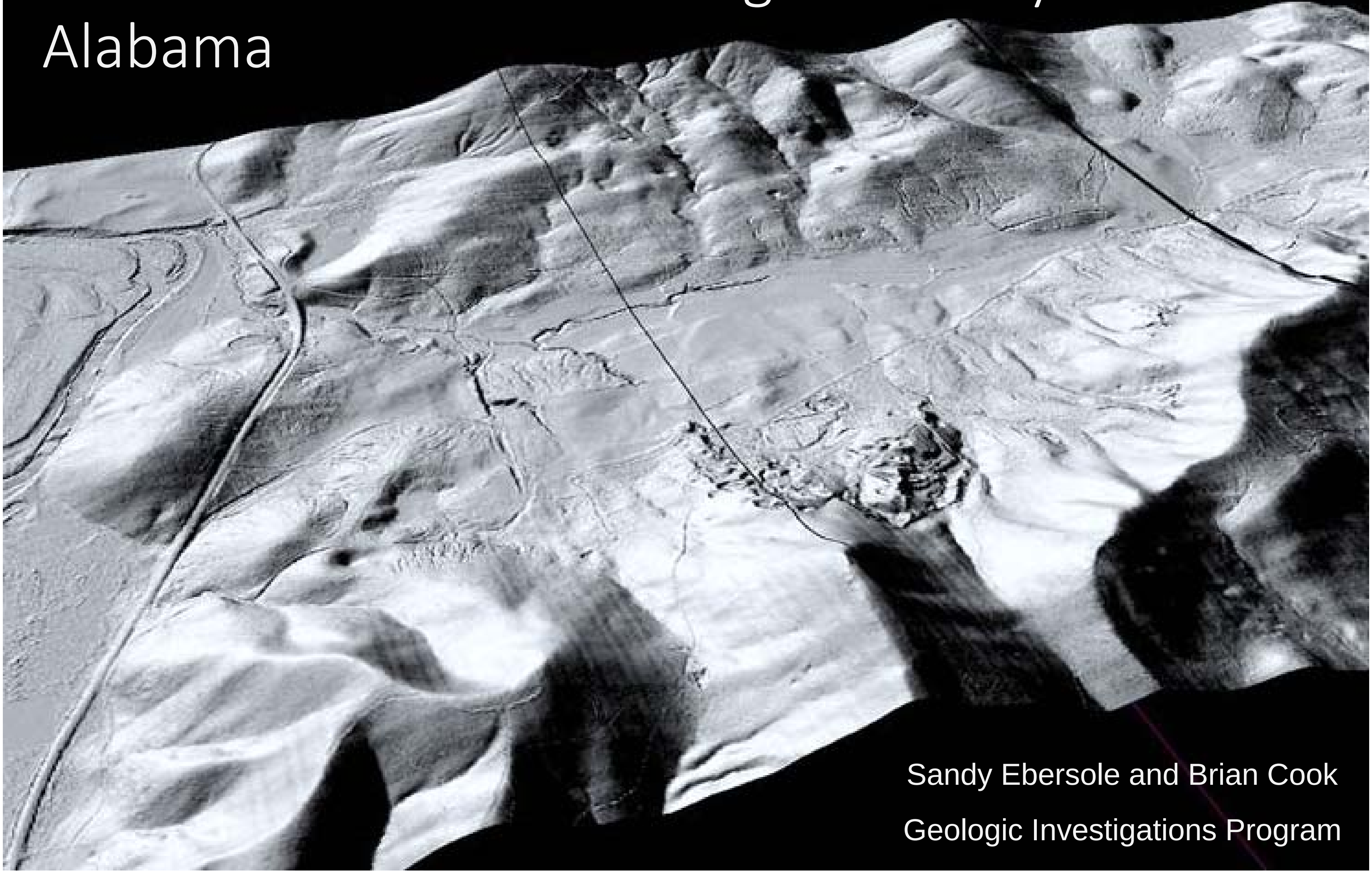
Geological Survey of Alabama, main website at http://www.gsa.state.al.us

U.S. Geological Survey, 2016, A 125 Year History of Topographic Mapping and GIS in the U.S. Geological Survey 1884-2009, Part 1, https://nationalmap.gov/ustopo/125history.html

U.S. Geological Survey, Science Explorer, multiple LiDAR publications are downloadable at https://www.usgs.gov/science/science-explorer

U.S. Geological Survey, 3D Elevation Program (3DEP), https://nationalmap.gov/3DEP/

Topographic Maps and LiDAR in Field Mapping and Research at the Geological Survey of Alabama



Sandy Ebersole and Brian Cook

Geologic Investigations Program

Included in this Presentation

- Challenges with topo maps in the field
- LiDAR and how it is applied in our work
- Future use/application of LiDAR at GSA

Mapping and Research at GSA

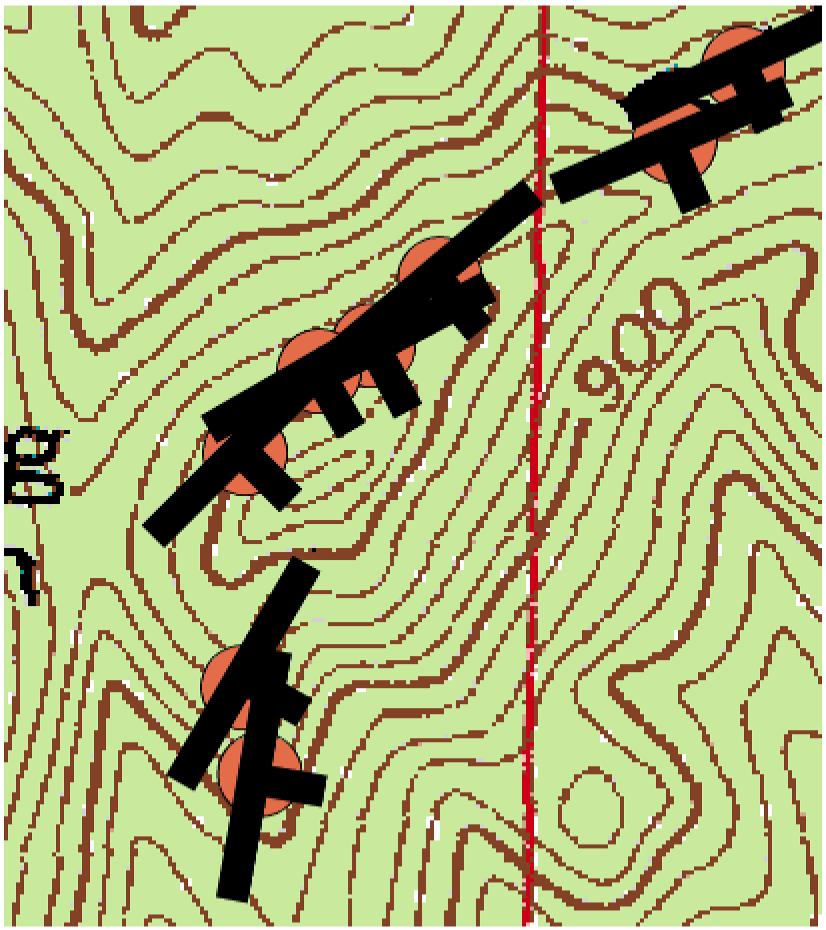
- Geological Survey of Alabama: Four programs
  - Geologic Investigation Program
  - Water Assessment Program
  - Ecosystems Investigation Program
  - Energy Investigation Program

- Each uses elevation data for mapping and research
  - Topographic maps (or NED)
  - SRTM
  - GPS
  - LiDAR

Intro to Topo Map Limitations

- Topographic Map Construction
  - Aerial imagery, not feasible to ground check
- Spatial limitation
  - Lateral, not ground checked everywhere
  - Vertical (*e.g.* contour intervals)
- Temporal limitation
- Land cover limitation
  - Densely forested areas

Example from field



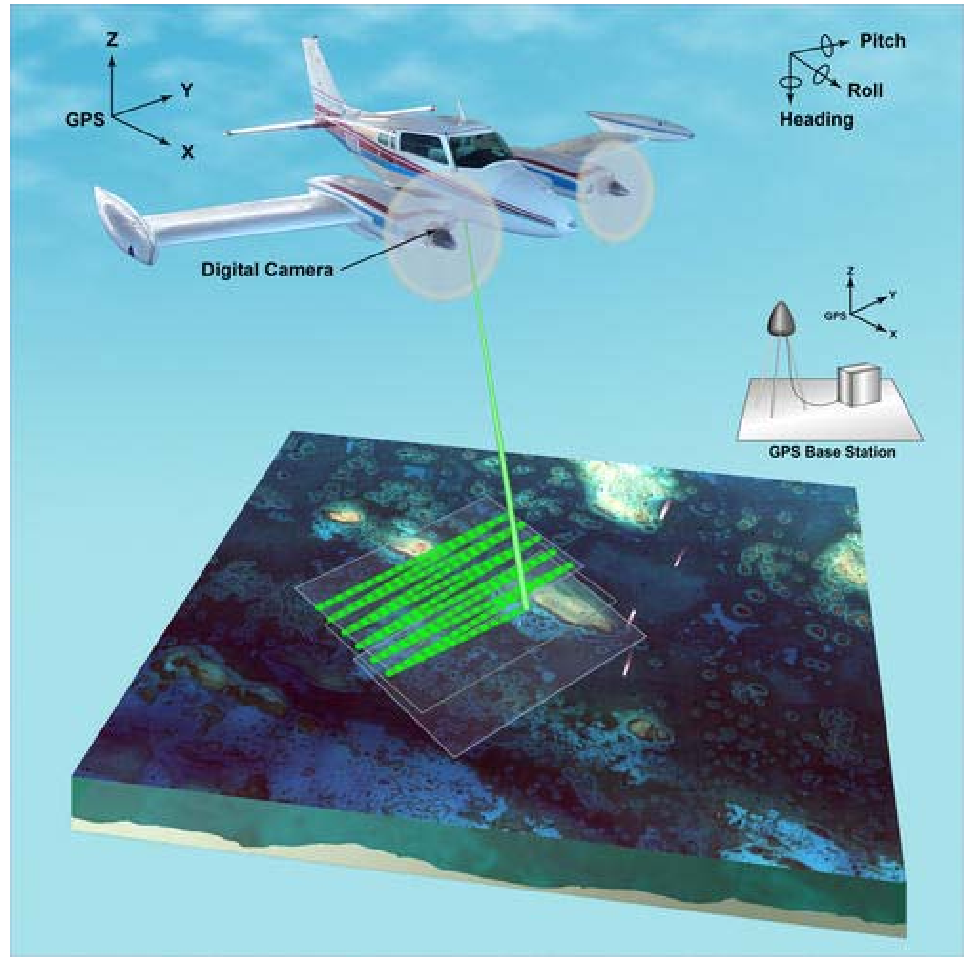
- Initially noticed mismatch between GPS location and actual topography
- Contour lines do not match the actual ridgeline as observed
- Possible solution?

LiDAR Intro

- LiDAR: Light Detection And Ranging
- Laser acquired elevation data
- Collected as either
  - Ground (tripod or handheld)
  - Aerial (plane, helicopter, or drone)

Aerial LiDAR

- GPS collects xy location of plane
- Laser shot from plane, bounces off ground, and returns to plane
- Sensor/software calculates time of return = distance from plane (z)

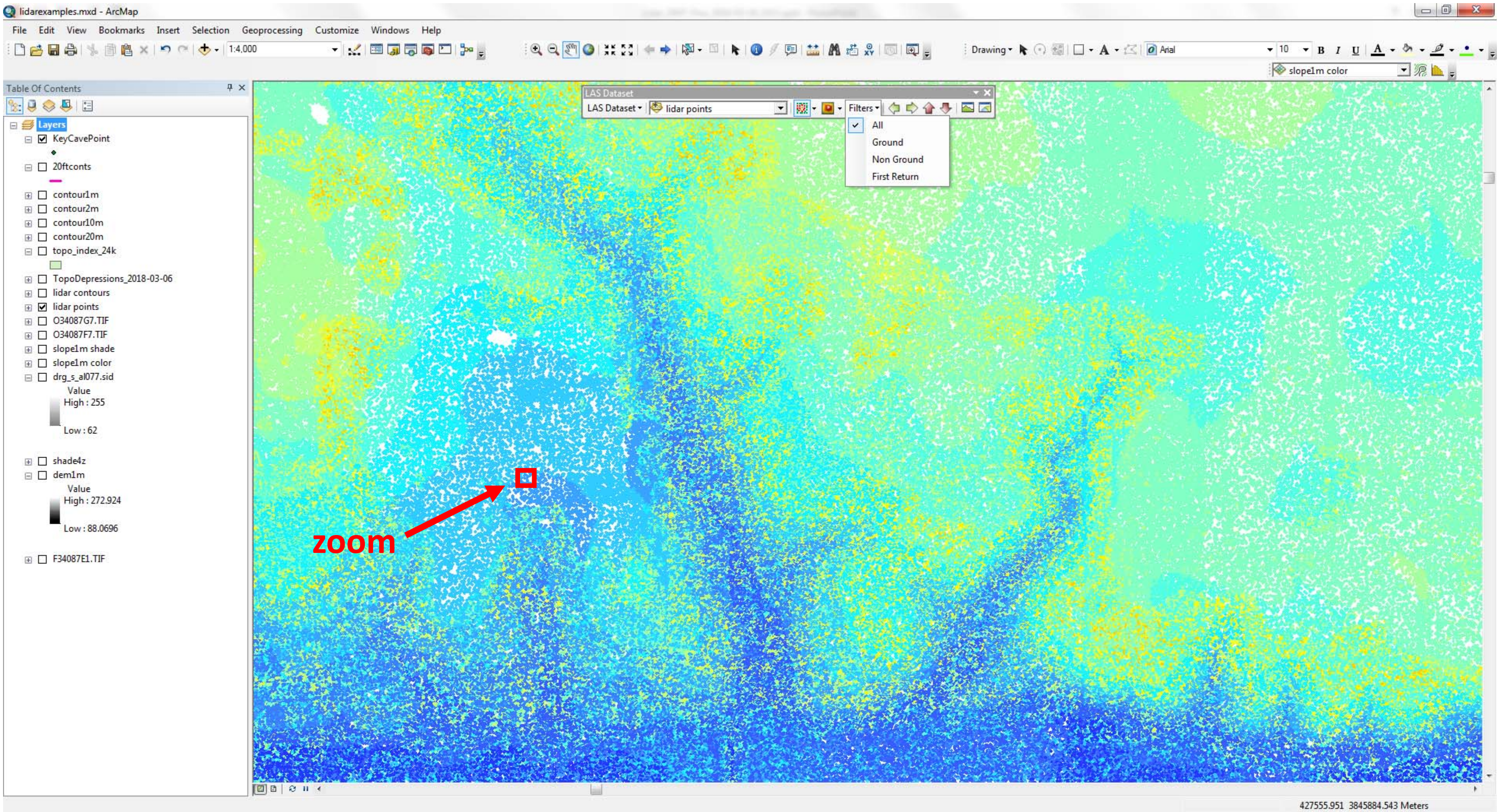


(Credit: Betsy Boynton. USGS.)

Points are Classified

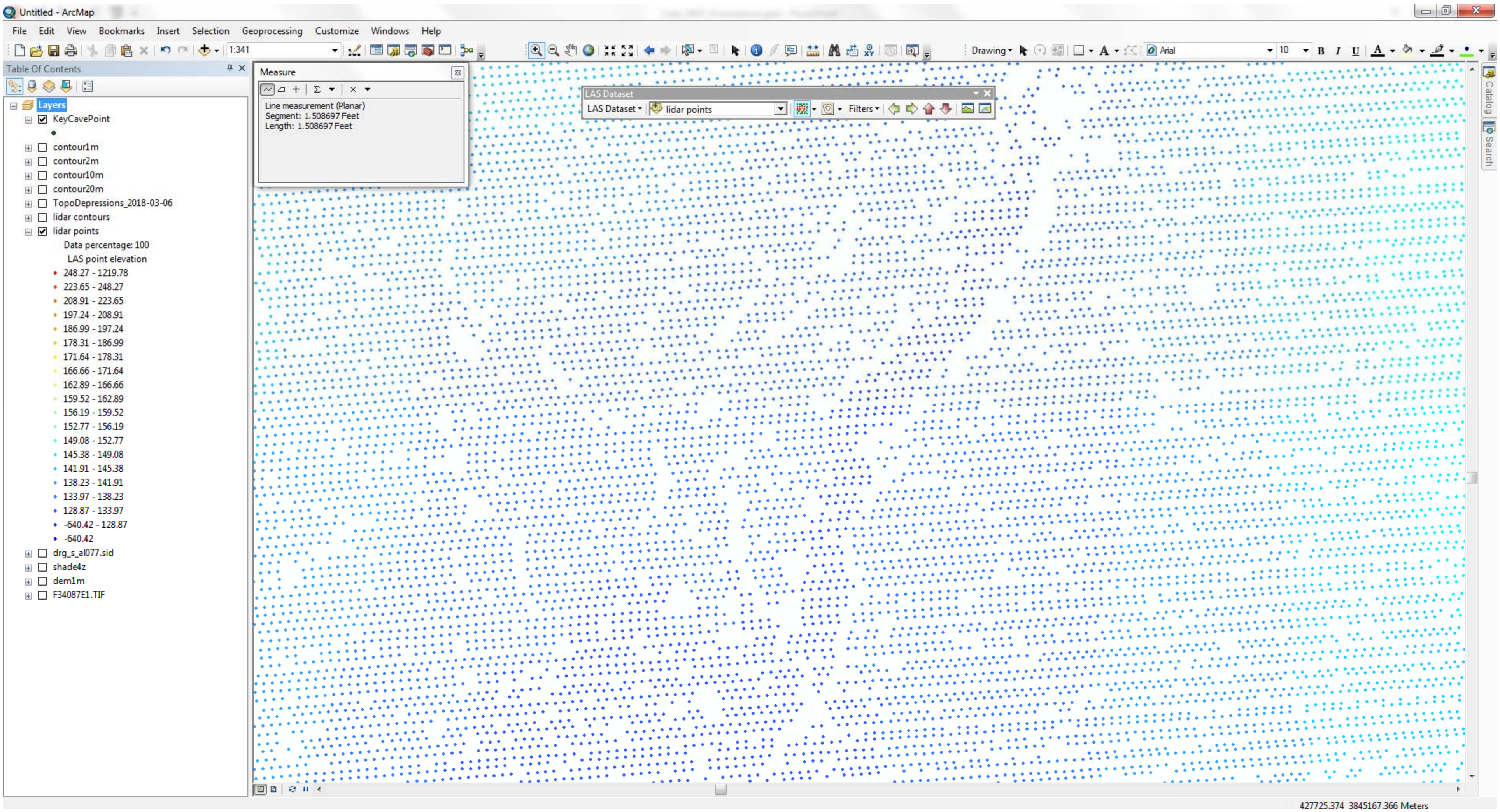
- Bare ground
- Water
- Urban areas, tall building
- Bridge deck
- High vegetation
- Low vegetation
- High noise
- Low noise
- Processed, but unclassified

LiDAR points



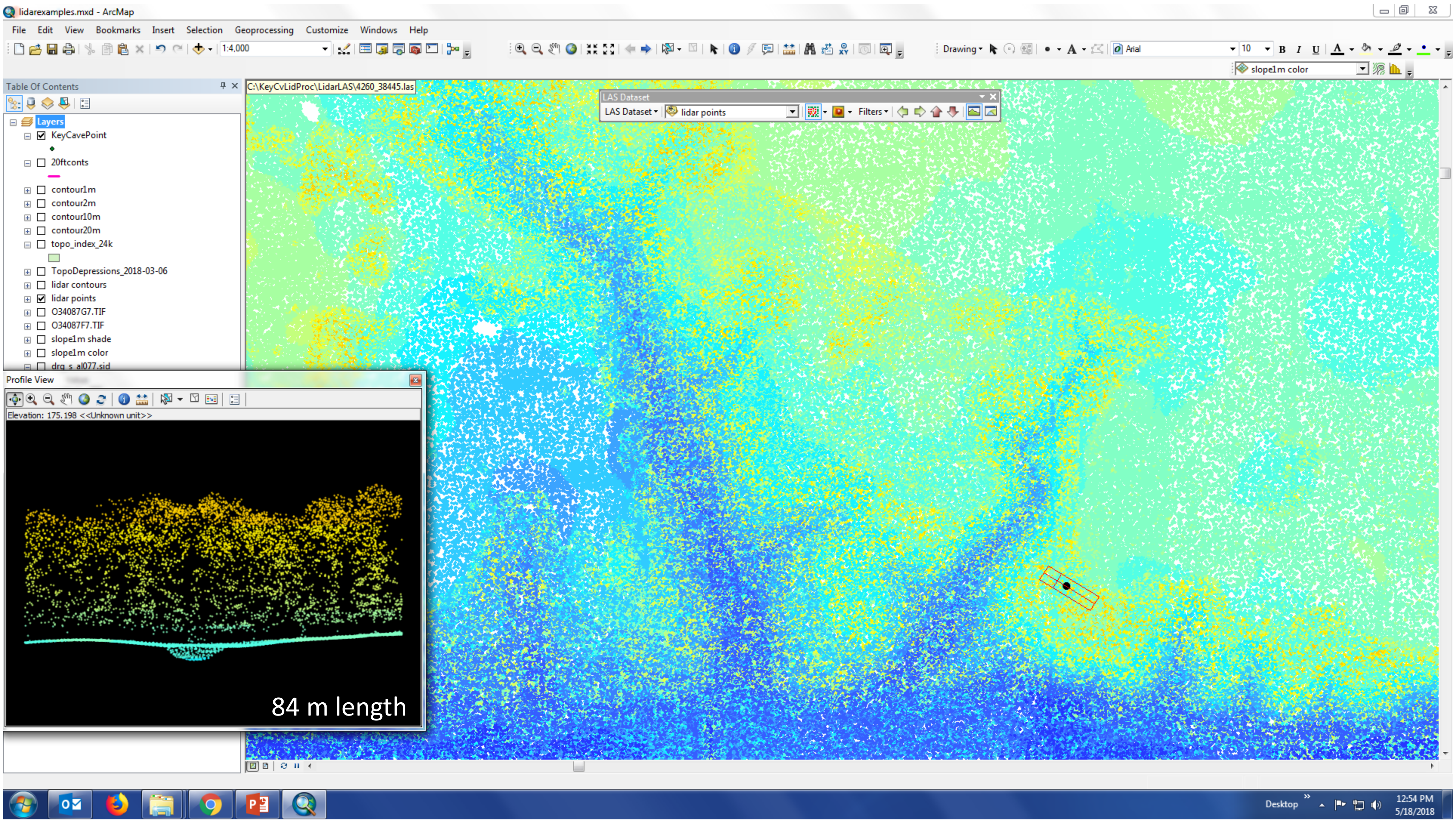
QL2 LiDAR points covering a 1-mile wide area, NW AL

Zoomed in, point-spacing varies



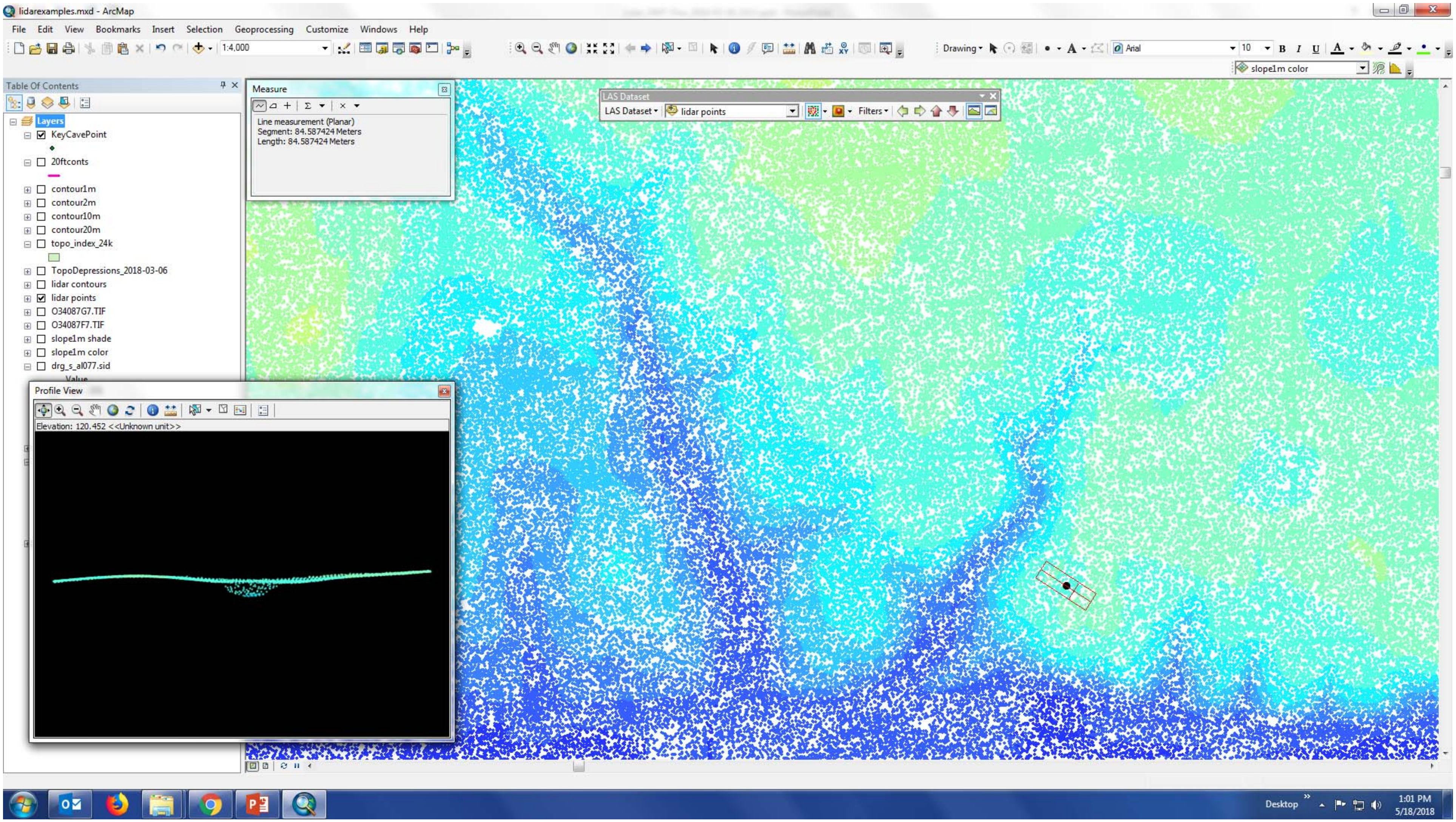
1 – 7 feet point spacing in places

Point cloud – All Points



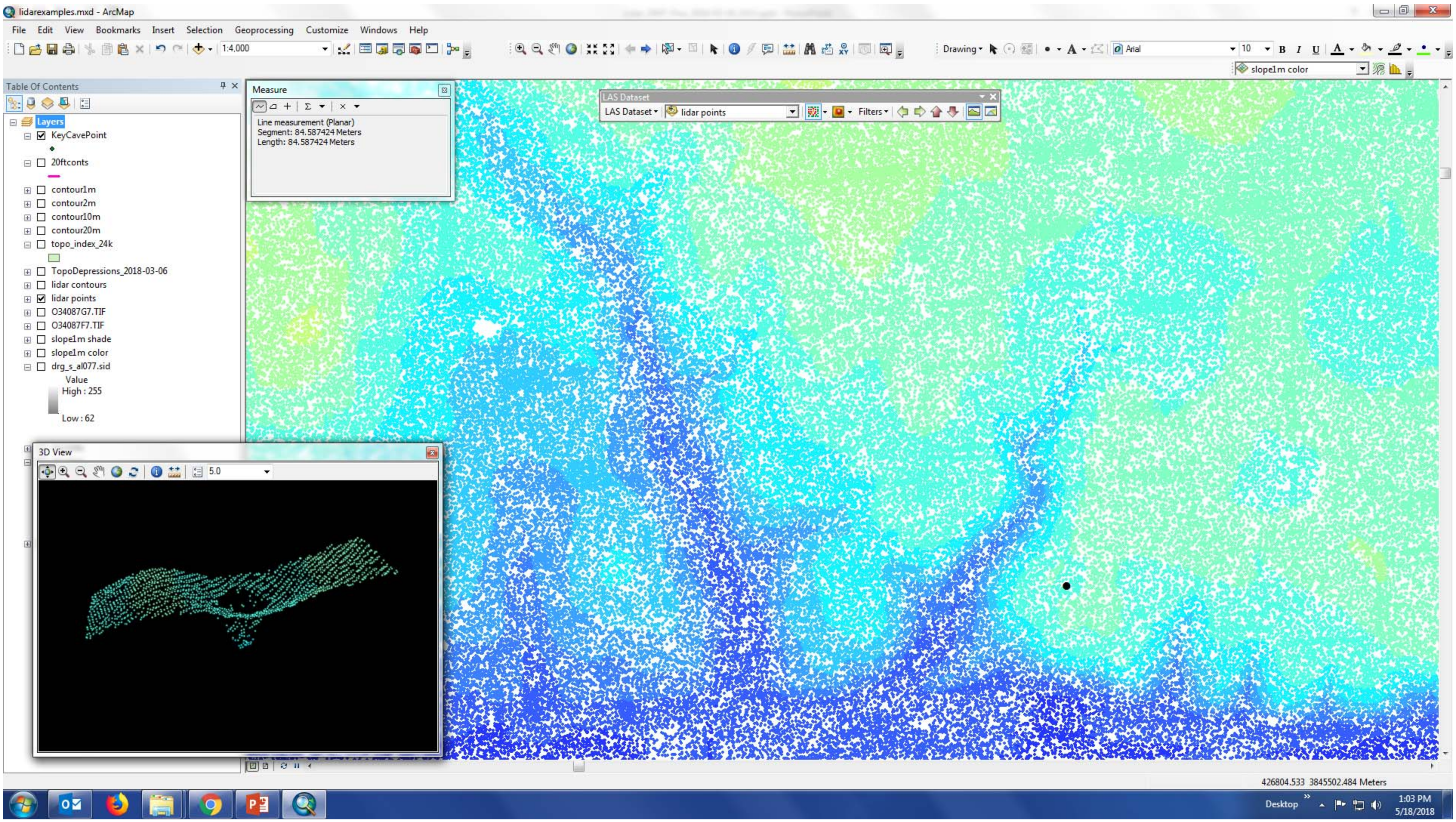
Canopy and ground as a 2D profile

Ground only



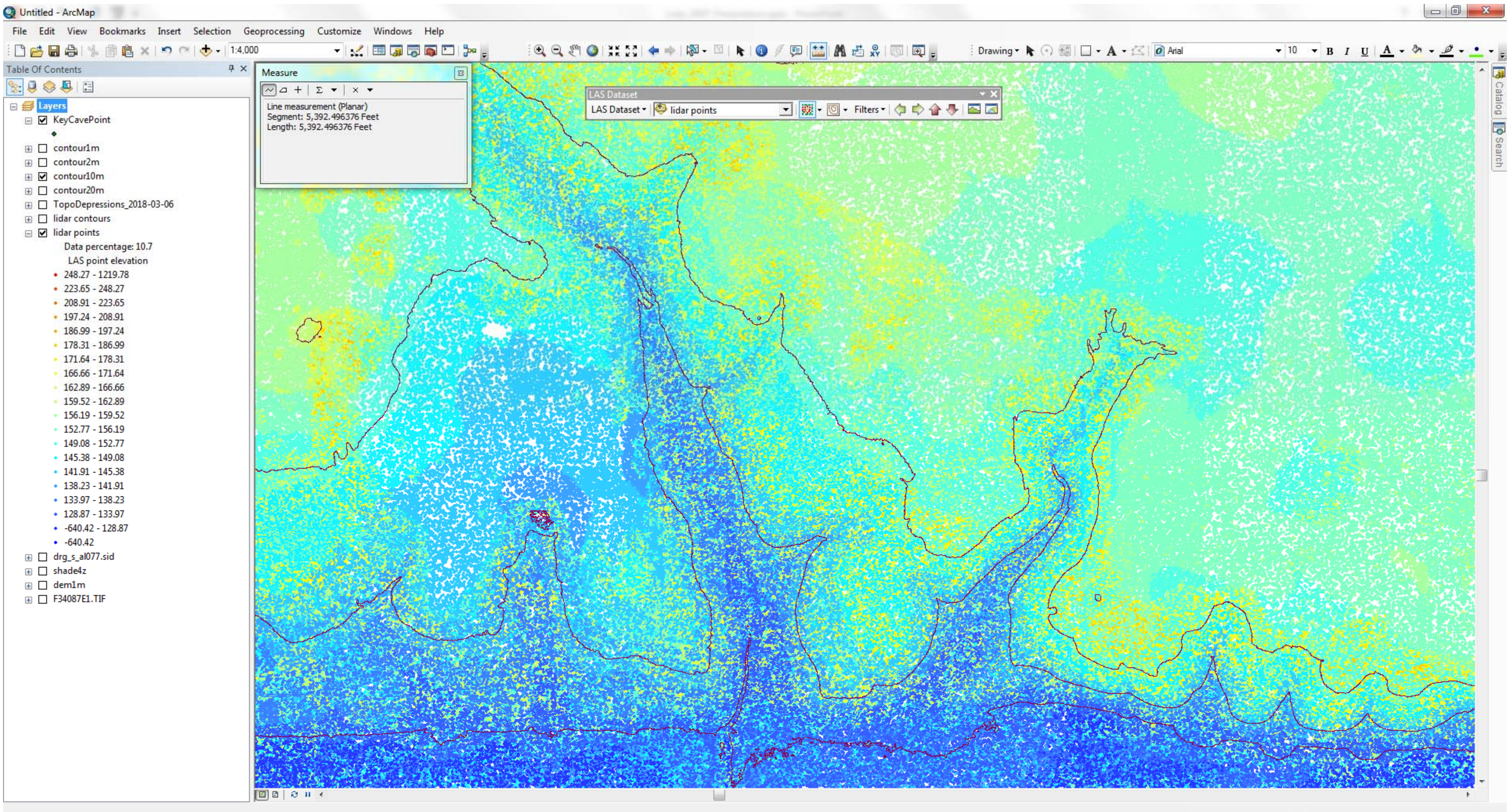
lidarexamples.mxd - ArcMap
File Edit View Bookmarks Insert Selection Geoprocessing Customize Windows Help
1:4,000
Drawing
Arial
10
slope1m color
Table Of Contents
Layers
KeyCavePoint
20ftconts
contour1m
contour2m
contour10m
contour20m
topo_index_24k
TopoDepressions_2018-03-06
lidar contours
lidar points
O34087G7.TIF
O34087F7.TIF
slope1m shade
slope1m color
drg_s_al077.sid
Measure
Line measurement (Planar)
Segment: 84.587424 Meters
Length: 84.587424 Meters
LAS Dataset
LAS Dataset
lidar points
Filters
Profile View
Elevation: 120.452 <<Unknown unit>>
Desktop
1:01 PM
5/18/2018

3D ground only with exaggeration

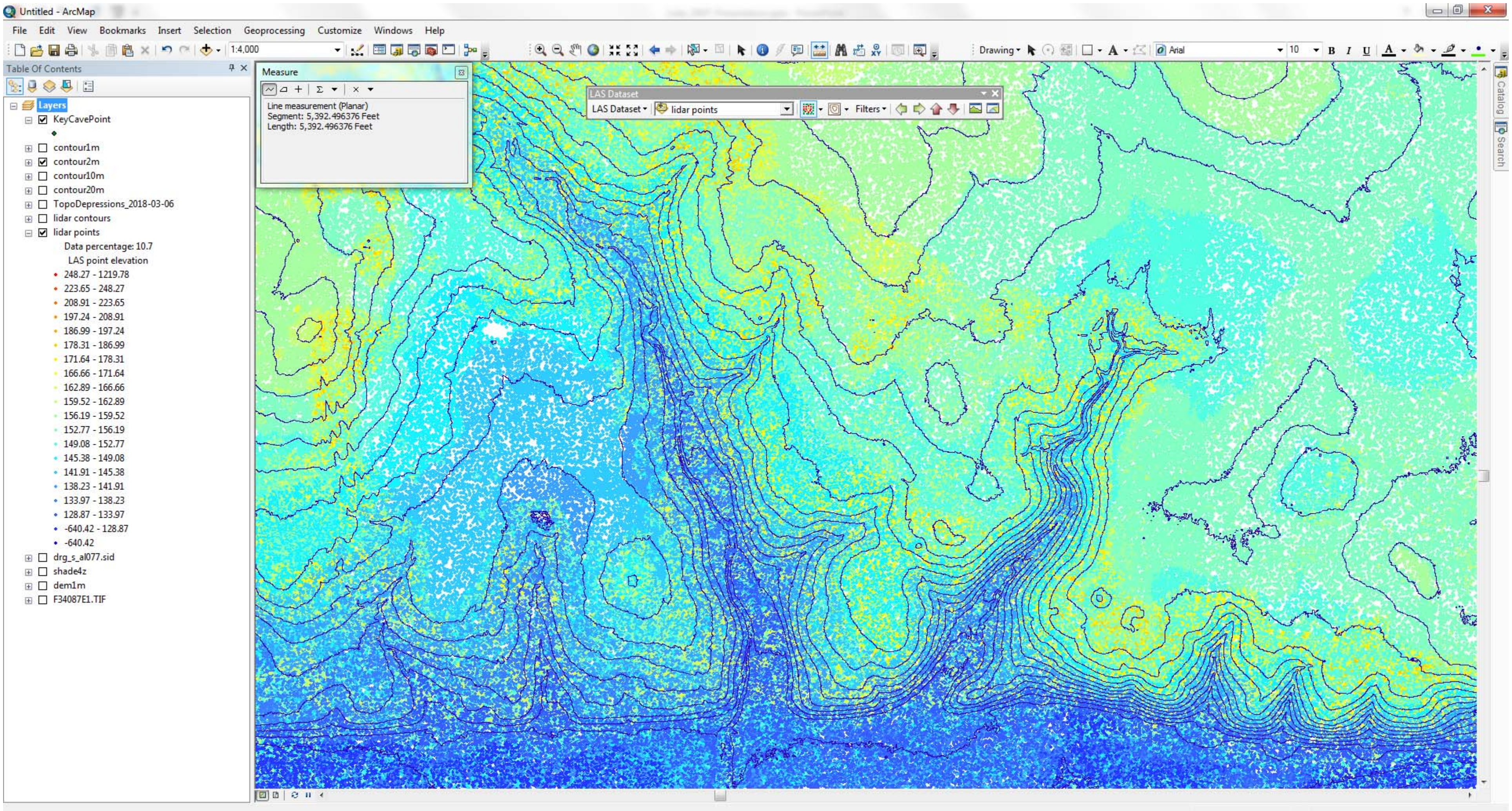


3D profile

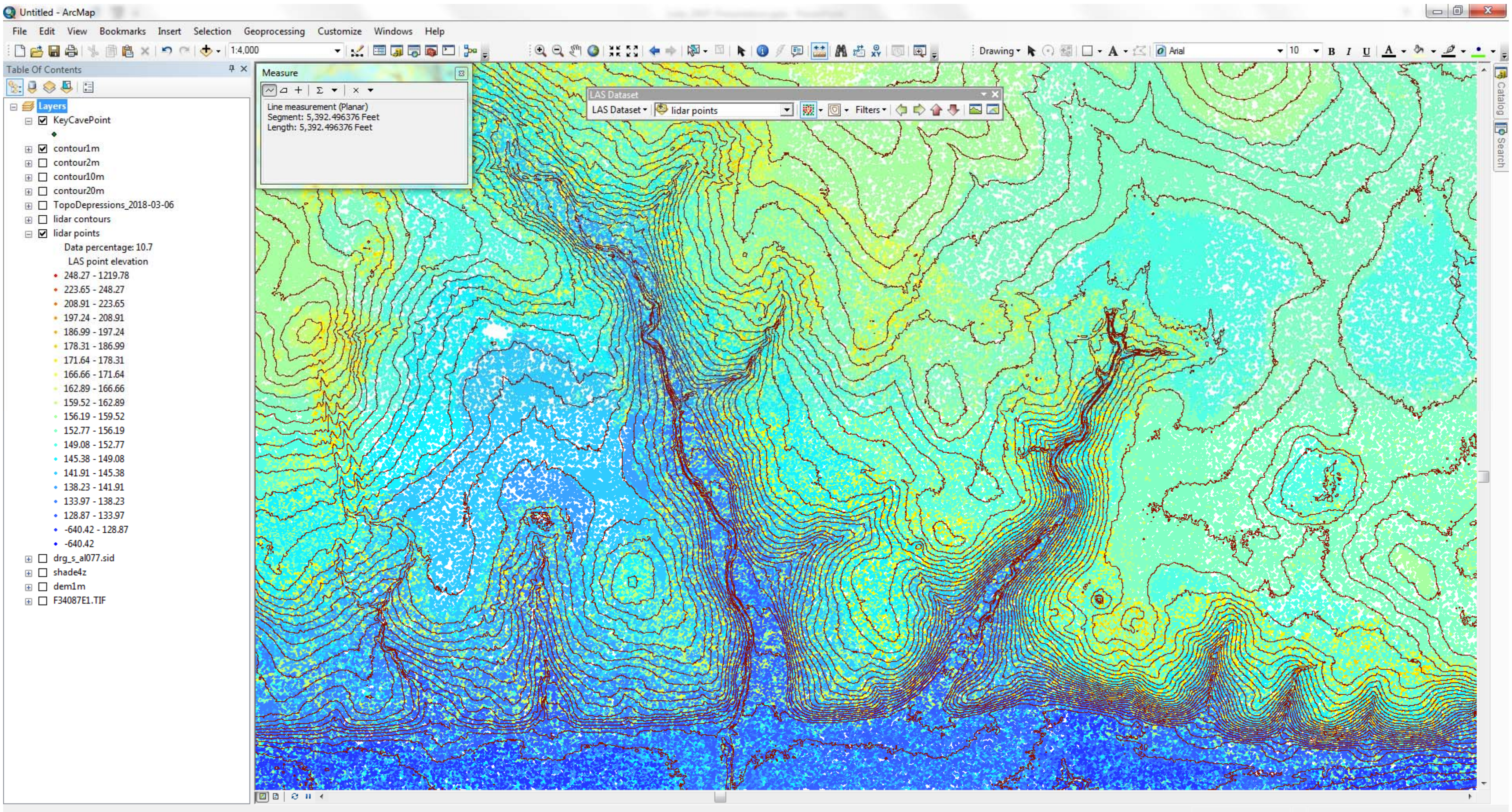
Derivative: 10-m contours



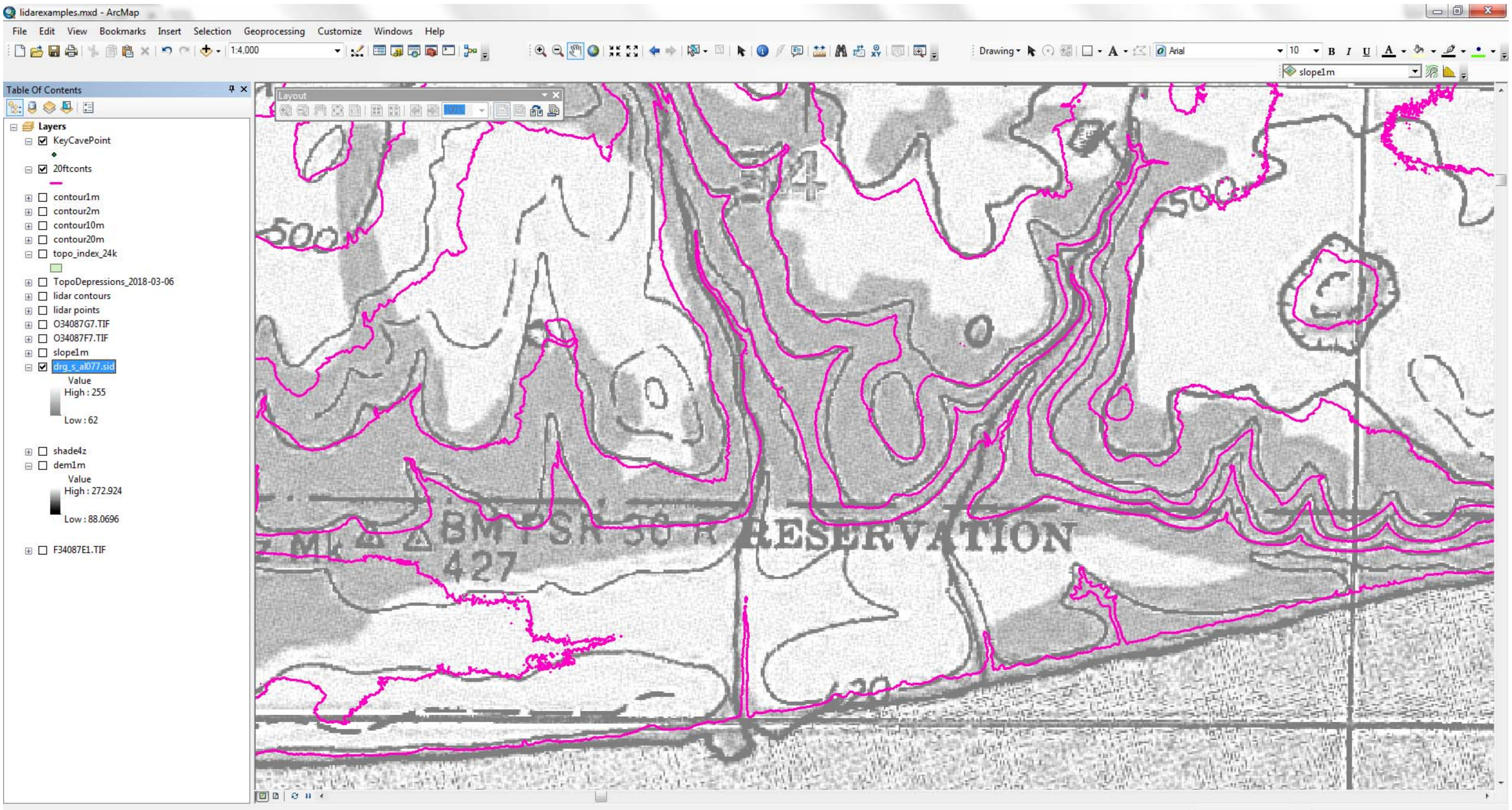
Derivative: 2-m contours



Derivative: 1-m contours

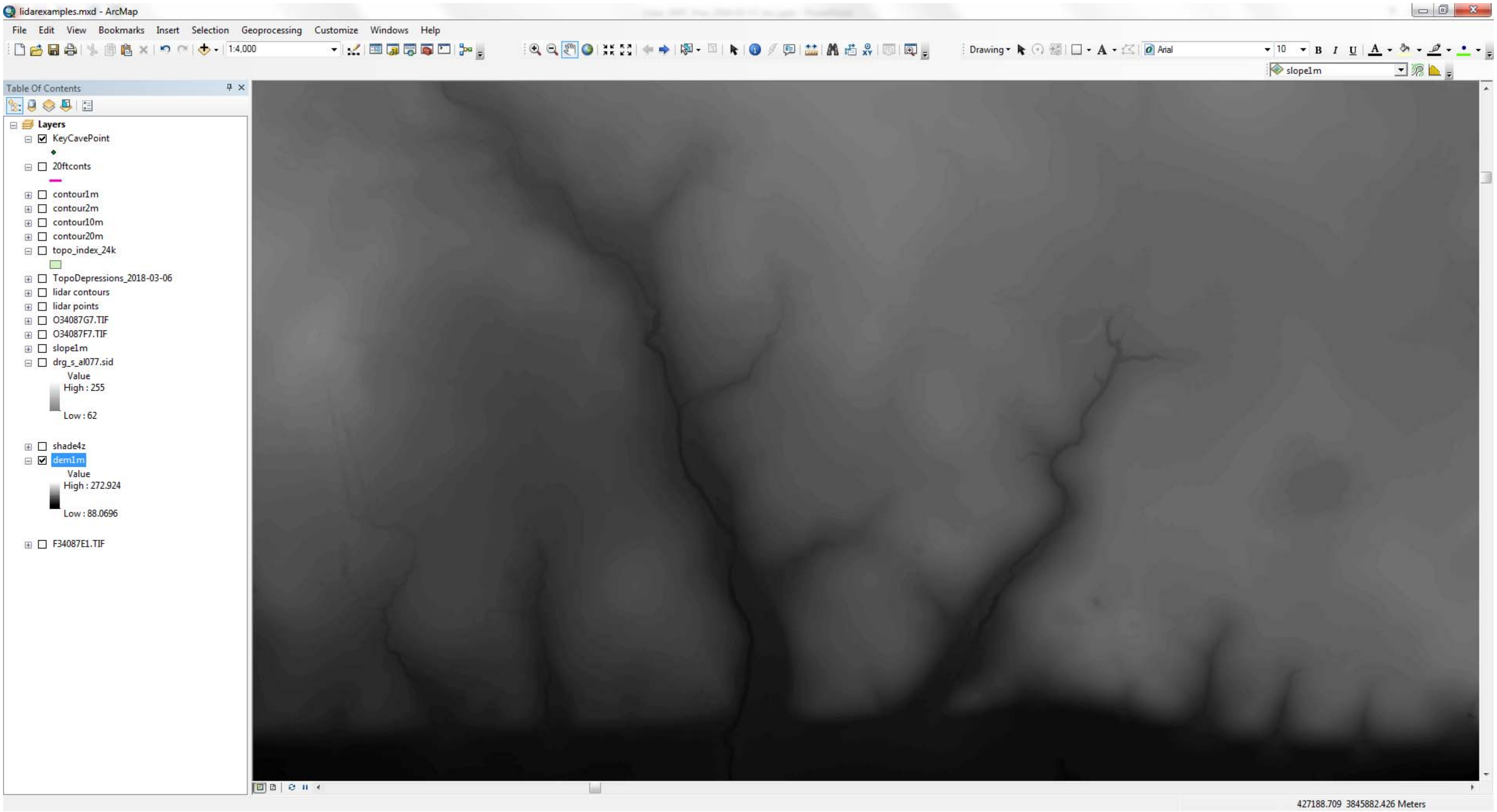


Derivative: 20ft contours compared w topo

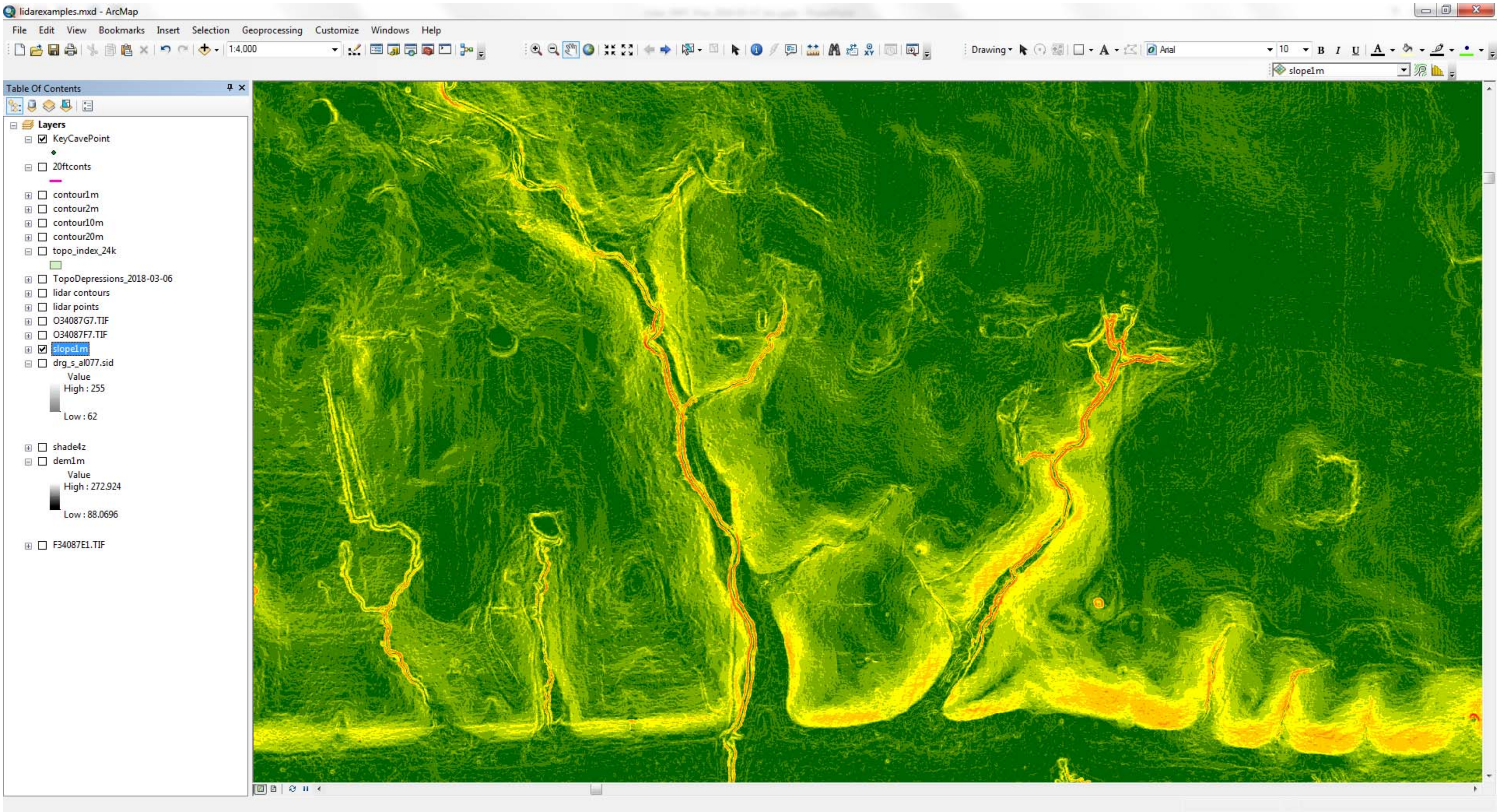


Same measurement, different places

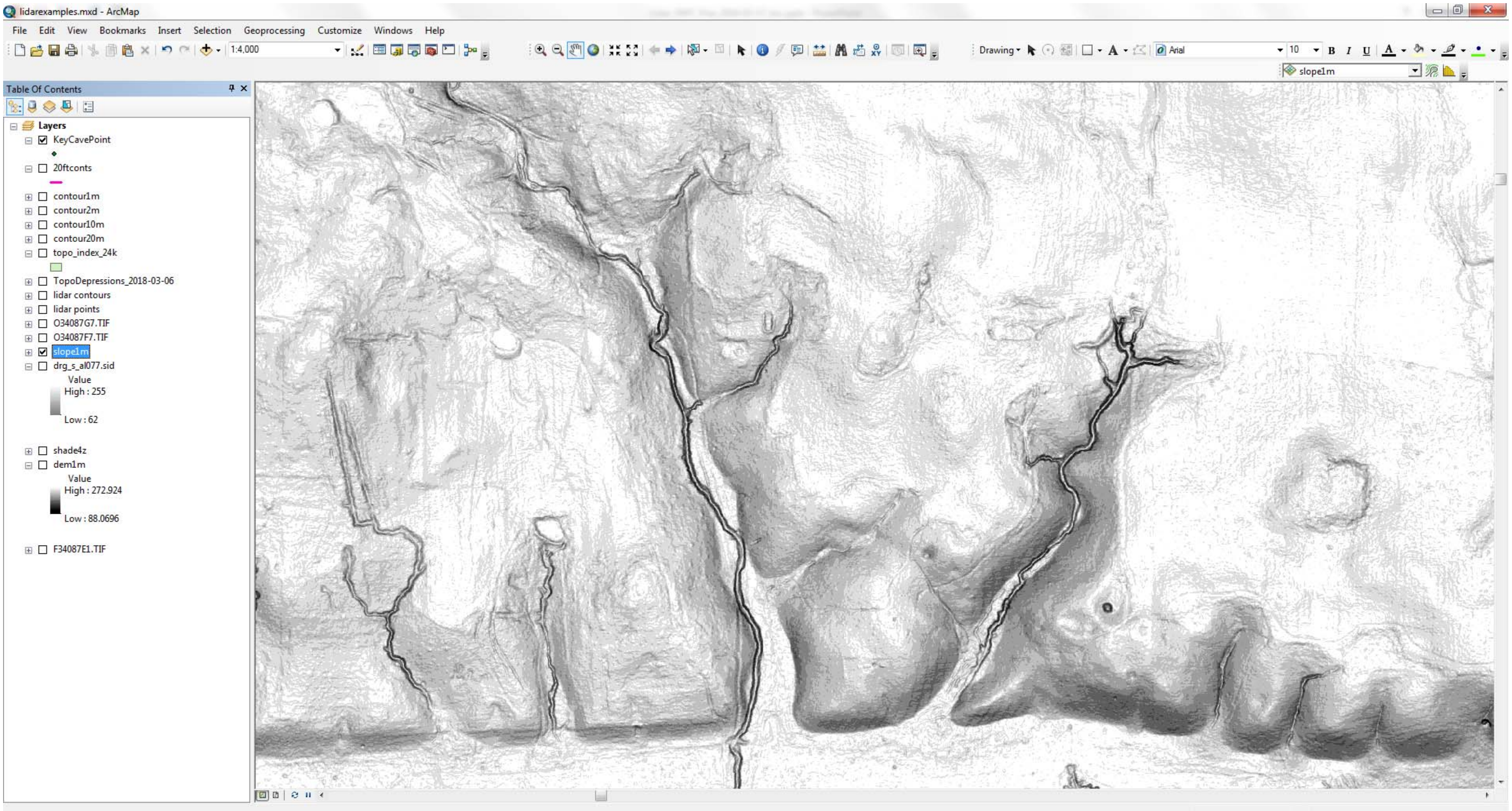
Derivative: Digital Elevation Model (DEM)



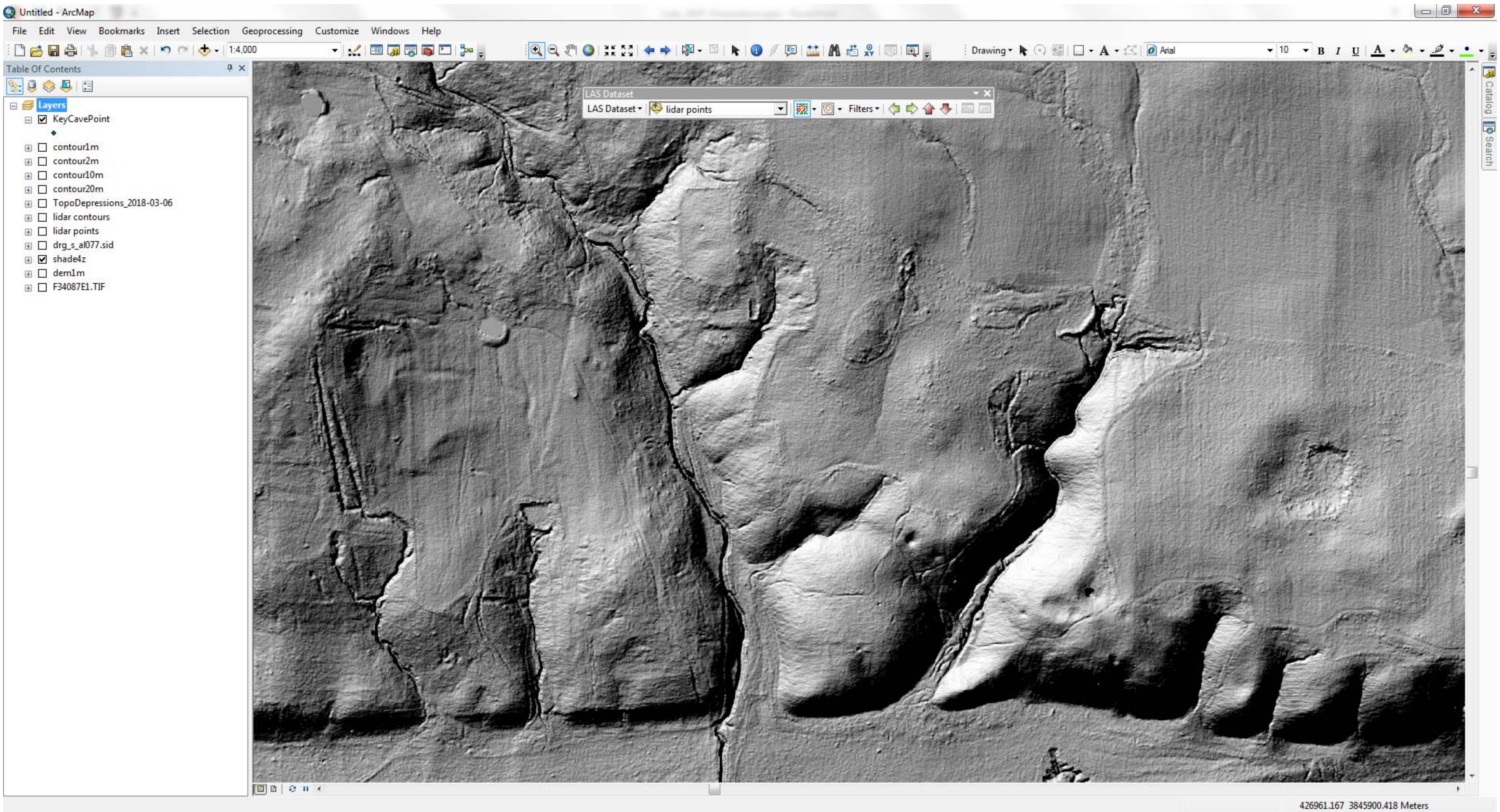
Derivative: Slope



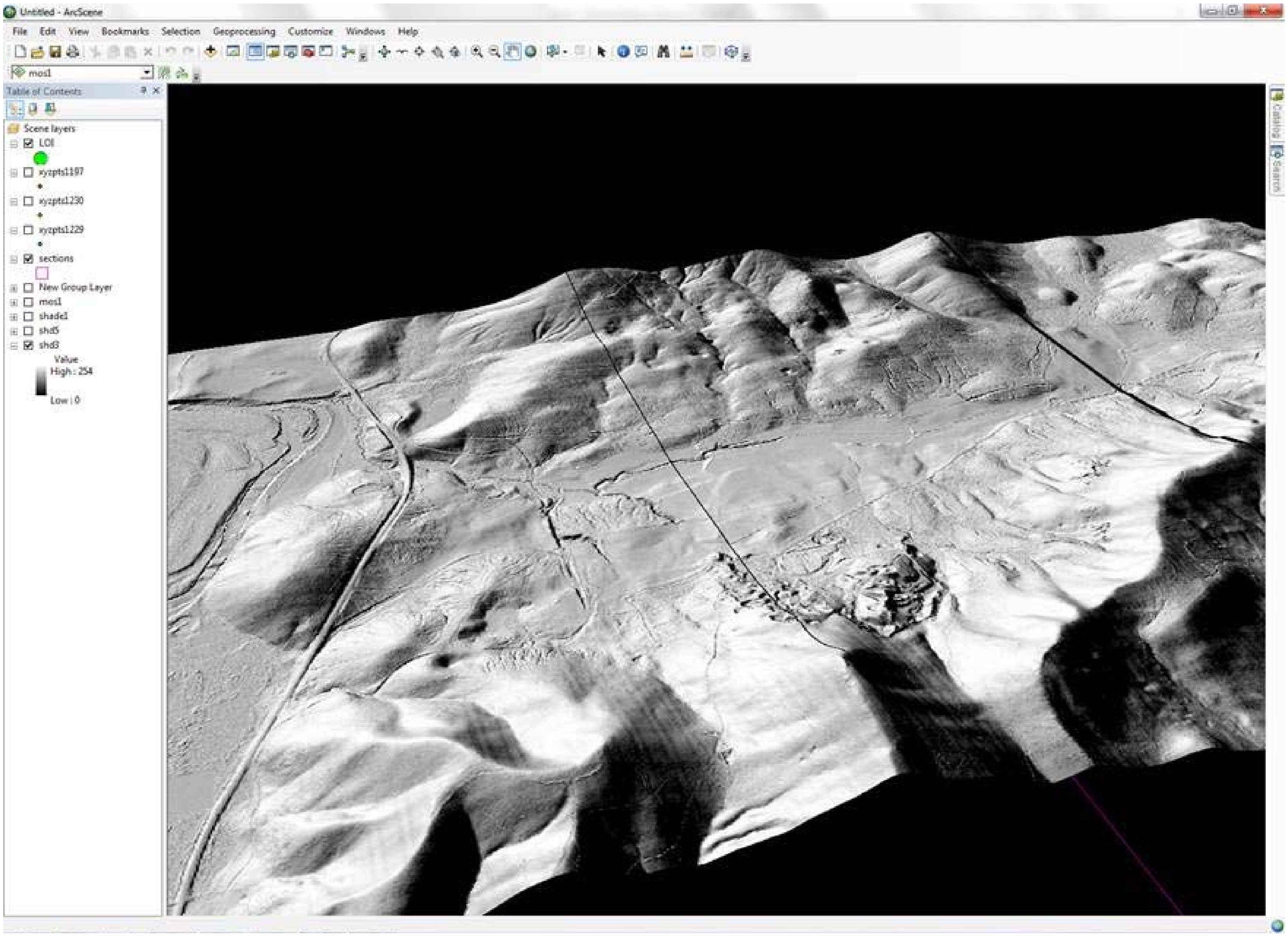
Derivative: Slope shade



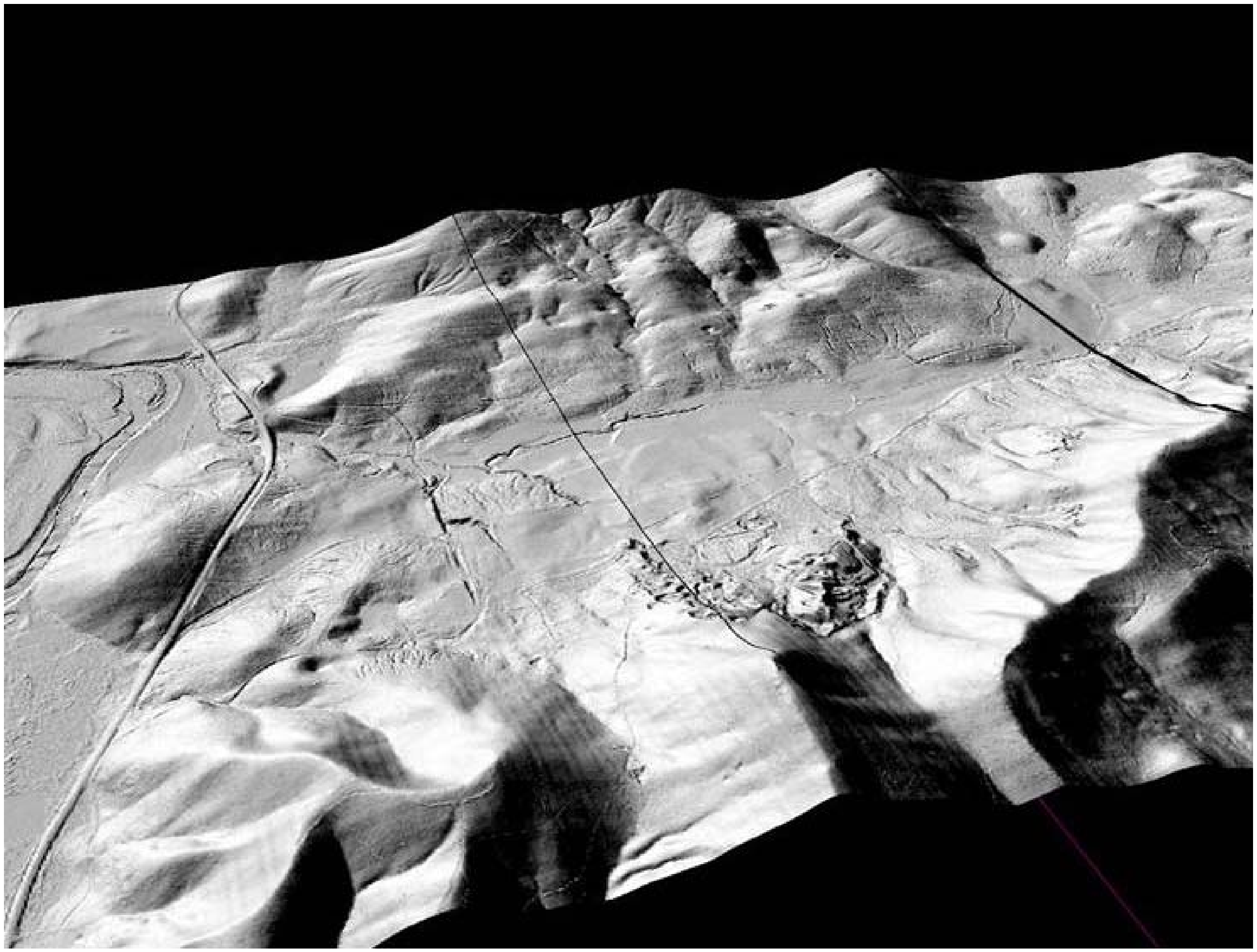
Derivative: Hillshade



Derivative: DEM as 3D in ArcScene



Applications in projects: Challenges and ways LiDAR helps

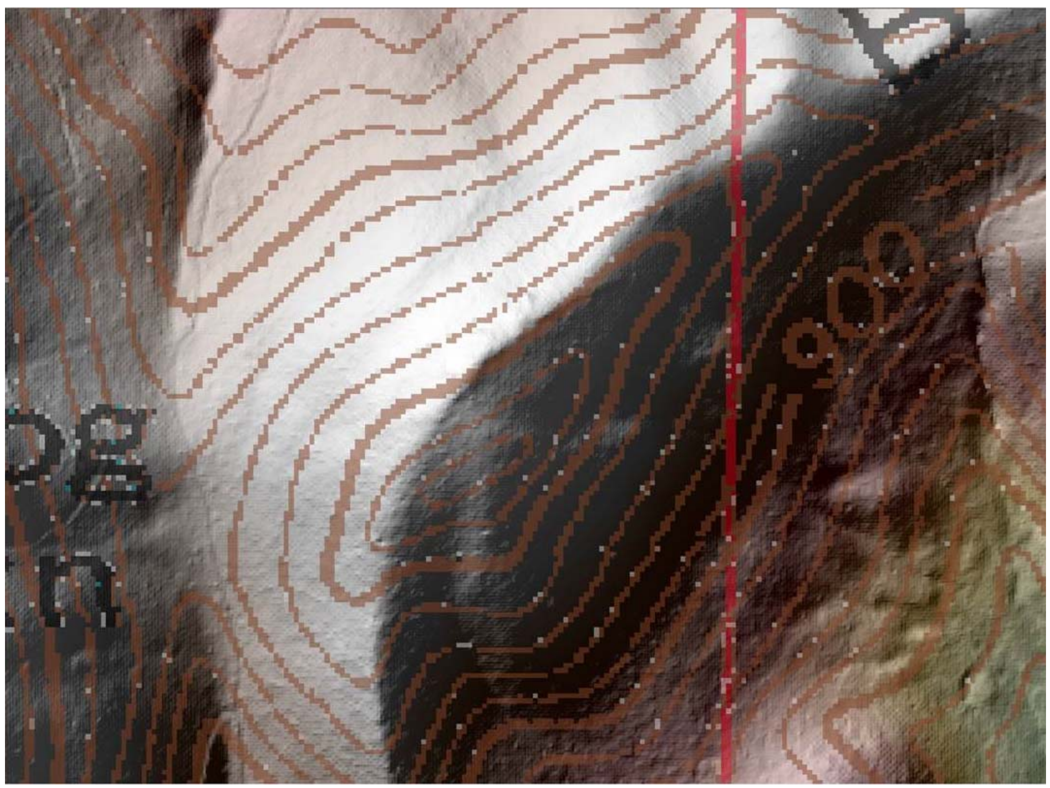


STATEMAP - Ellisville Geologic Quadrangle

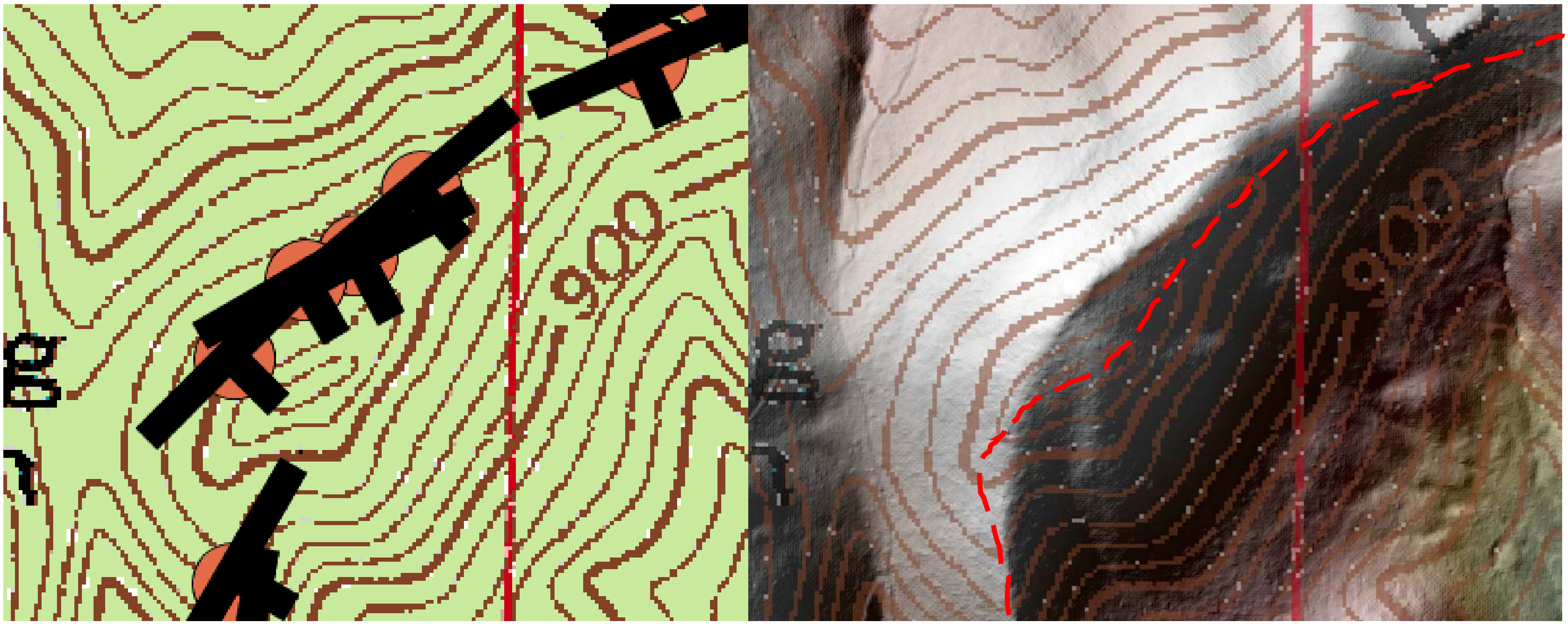
- Challenges:
  - GPS showed different xyz on topo map with respect to ridgeline
  - What other features can be observed?

STATEMAP - Ellisville Geologic Quadrangle

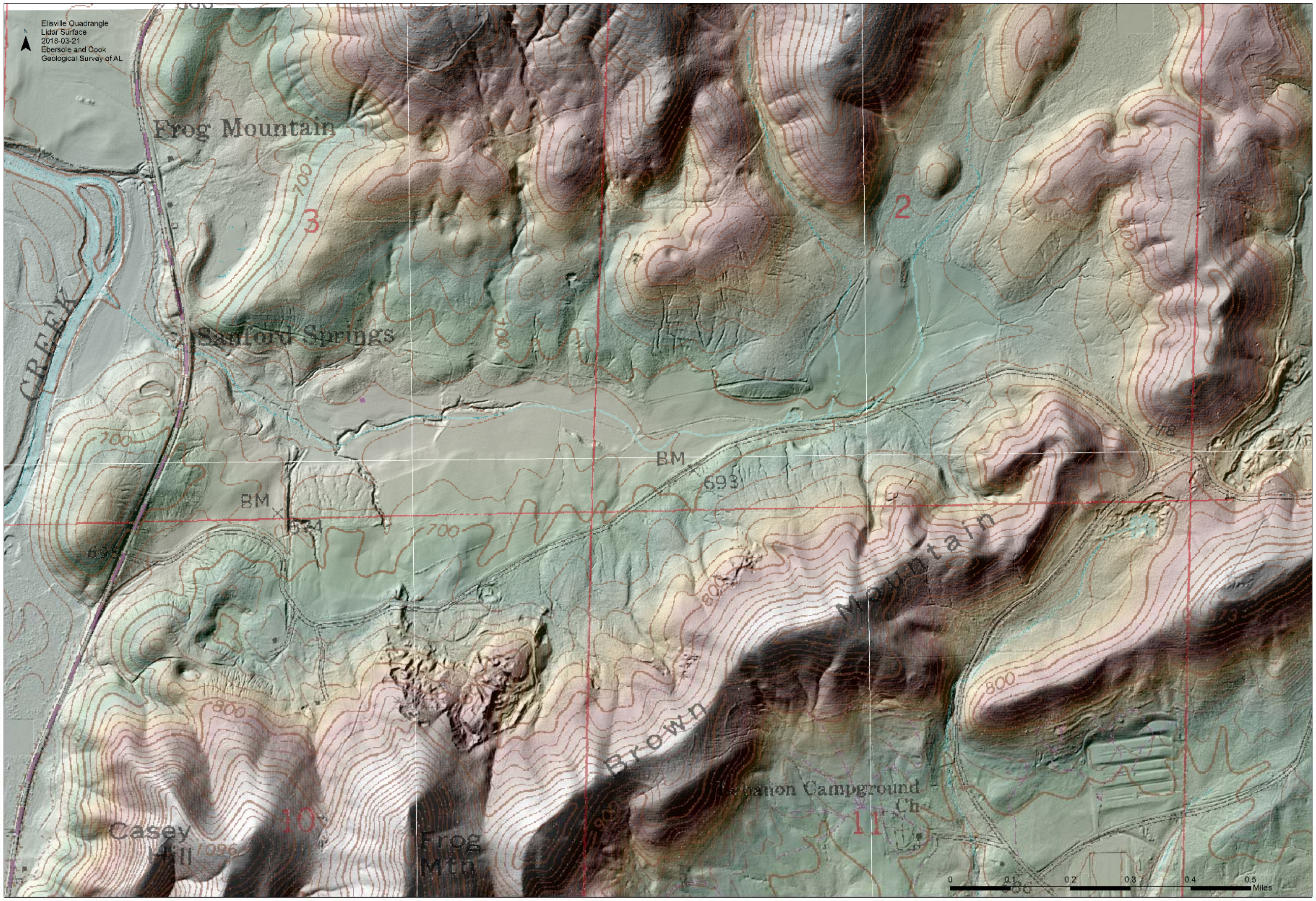
- Identifying exact location
- Identifying elevation with improved accuracy



STATEMAP - Ellisville Geologic Quadrangle

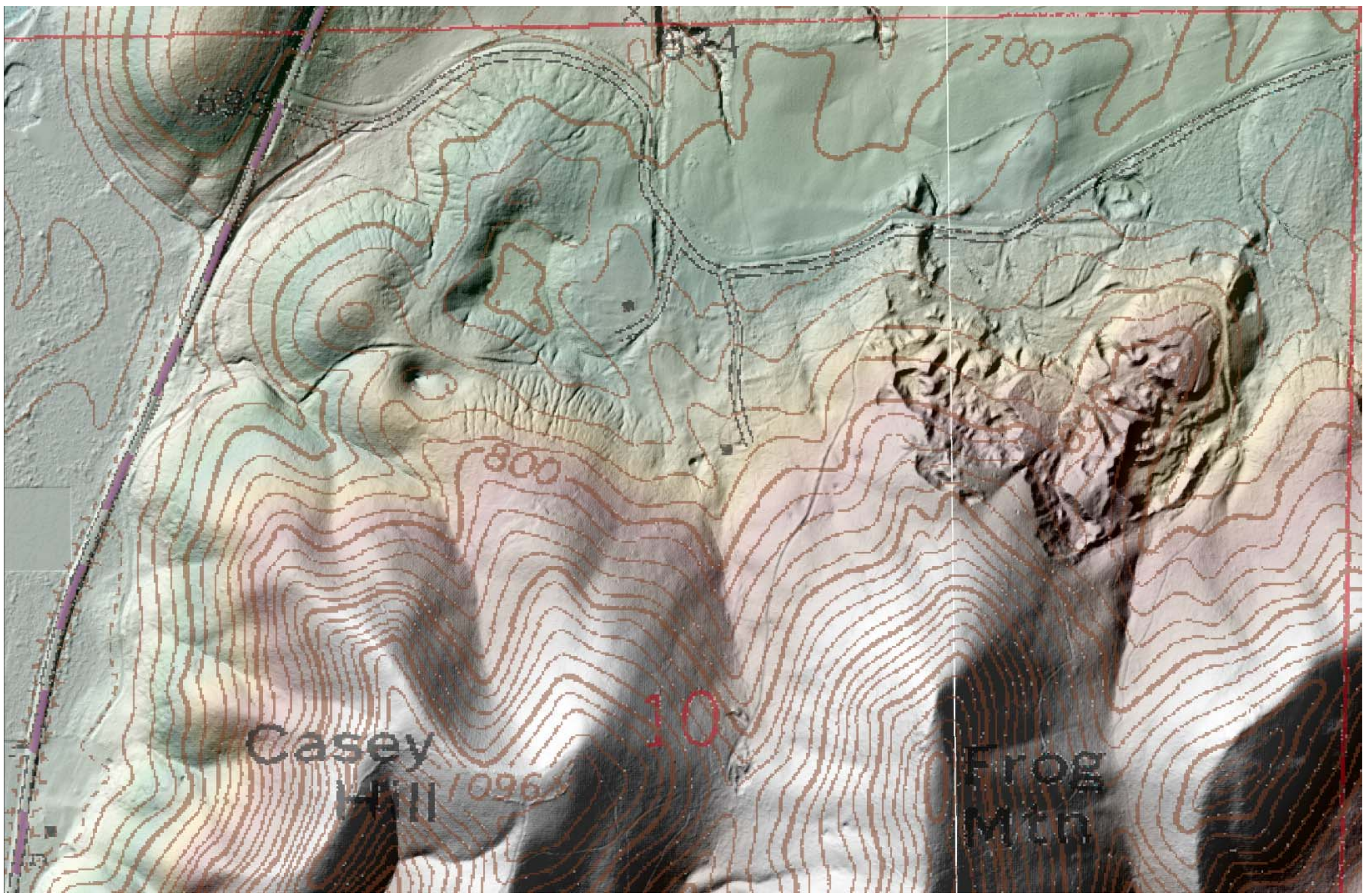


STATEMAP - Ellisville Geologic Quadrangle



STATEMAP - Ellisville Geologic Quadrangle

- Trails/abandoned roads – good for hiking into remote areas
- Possible outcrops in cut banks



STATEMAP - Ellisville Geologic Quadrangle

- Identifying anthropogenic features

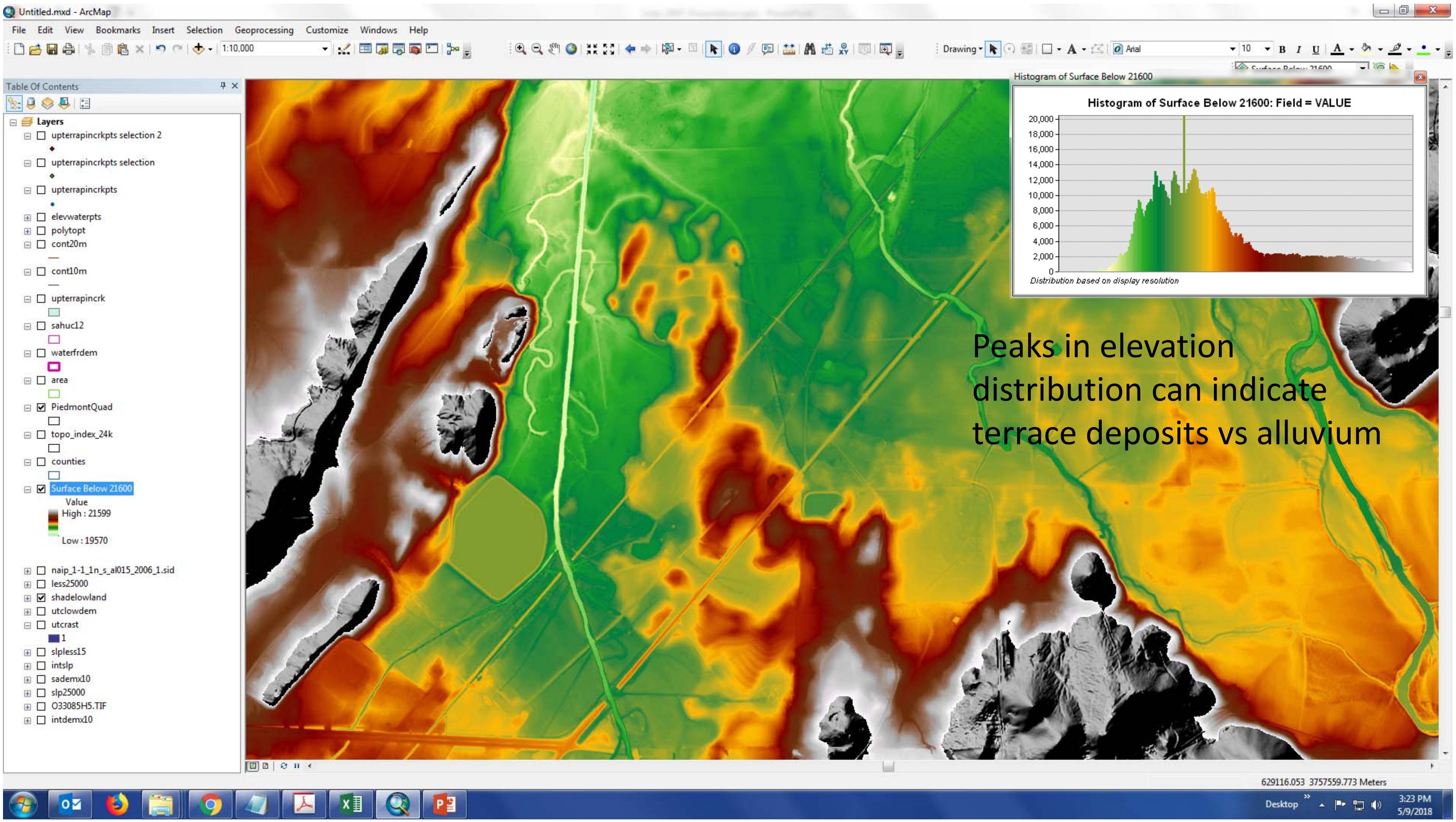
STATEMAP - Ellisville Geologic Quadrangle

- Identifying paleokarst features

STATEMAP - Piedmont Geologic Quadrangle

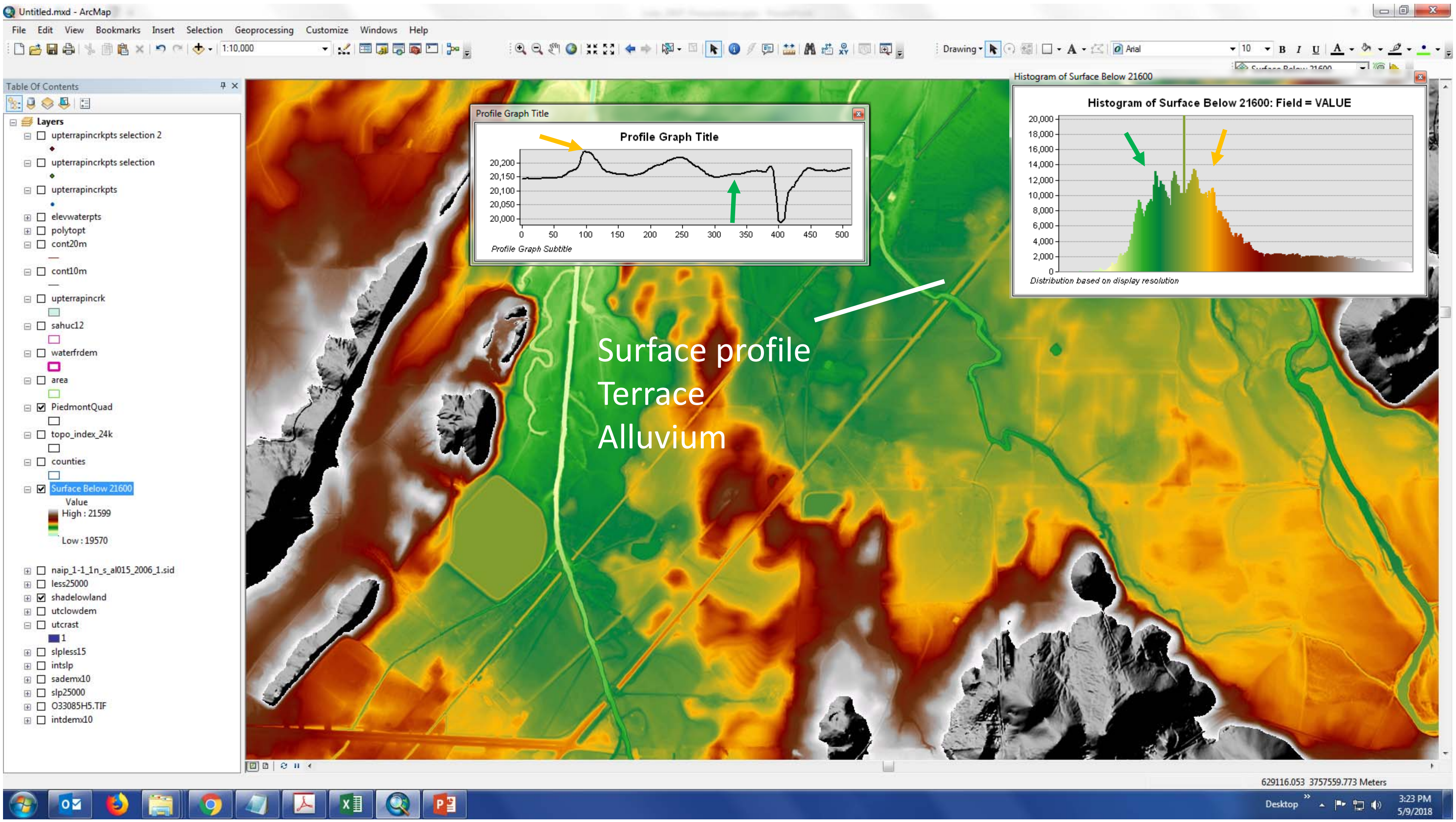
- Challenges:
  - What is the broadest extent of the alluvium?
  - How/where to separate alluvium from terrace deposits?

STATEMAP – Piedmont Geologic Quad.



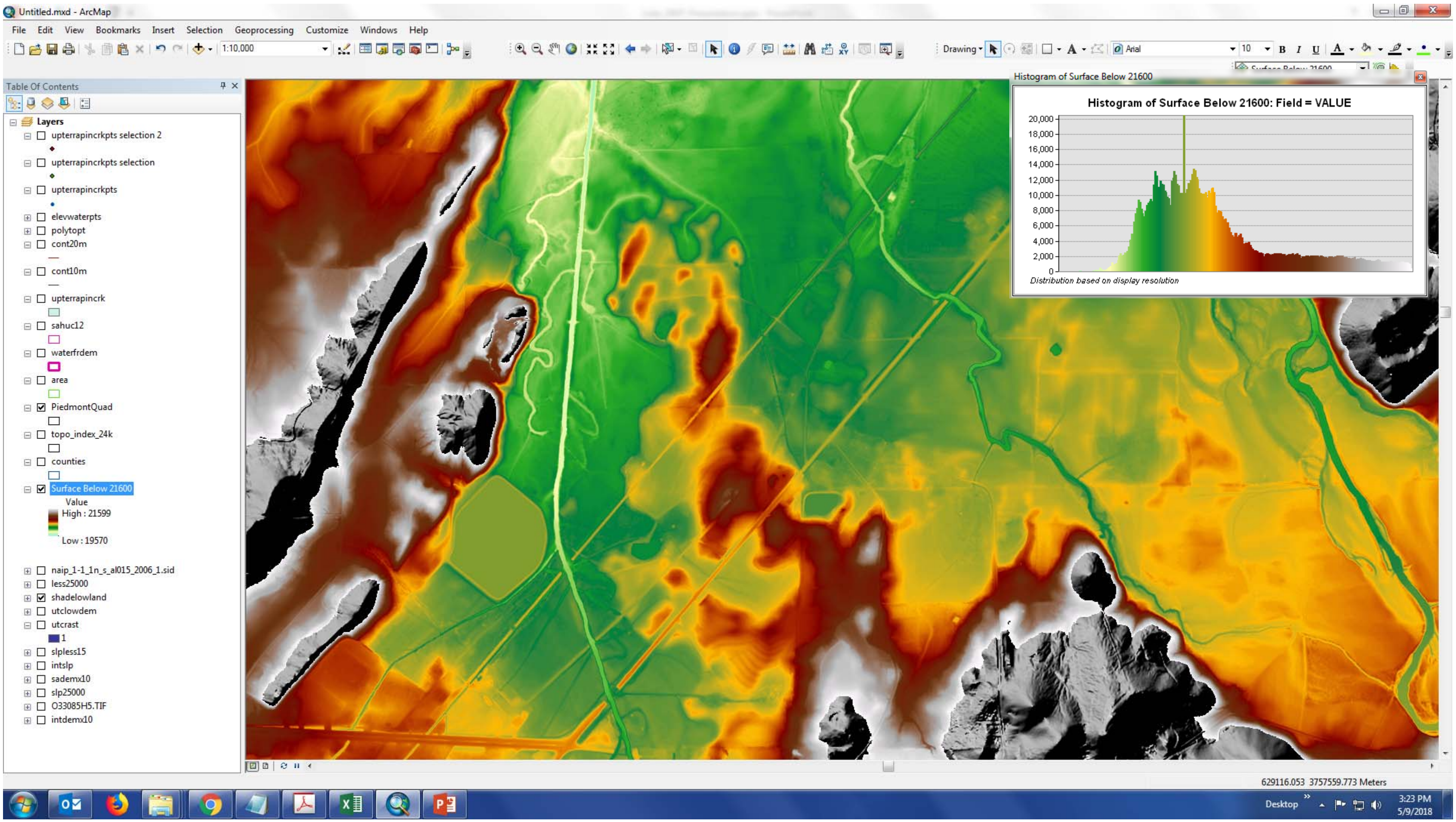
Spatial statistics – histogram of elevation distribution (relative to river/stream elevation)

Elevation separation of surficial geology



Further explore those populations using surface profiles tools

Next steps: Separate peaks to shapefiles for Qal and Qt – then cross check with field



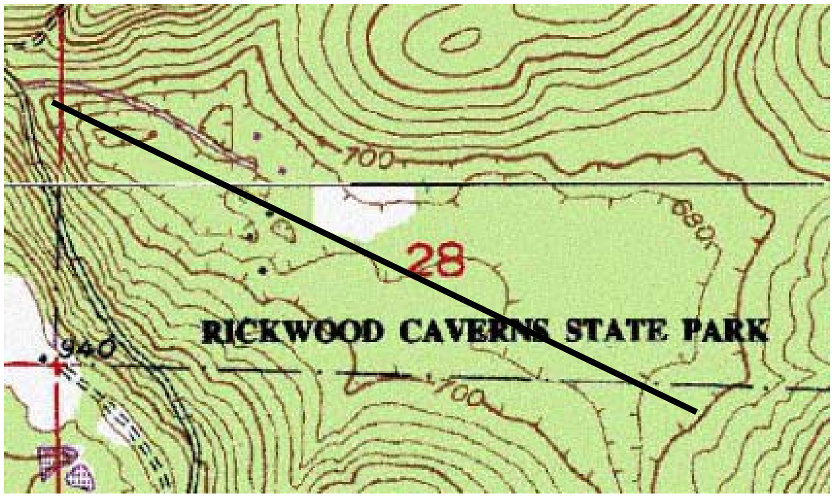
Difficulties in areas changed by development

Environmental Karst Hydrology

- Challenges:
  - Locating sinkholes in large basins
  - Hydrology/drainage analyses

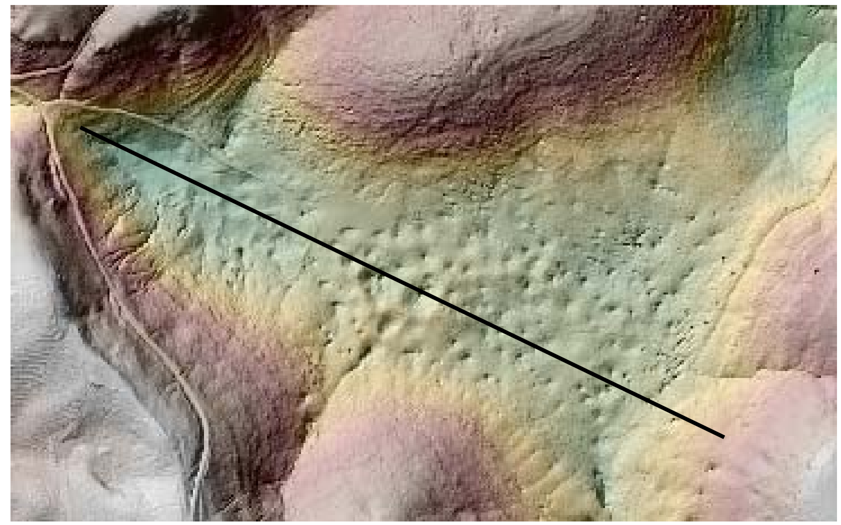
Details help identify surface to groundwater

7.5' Topographic map

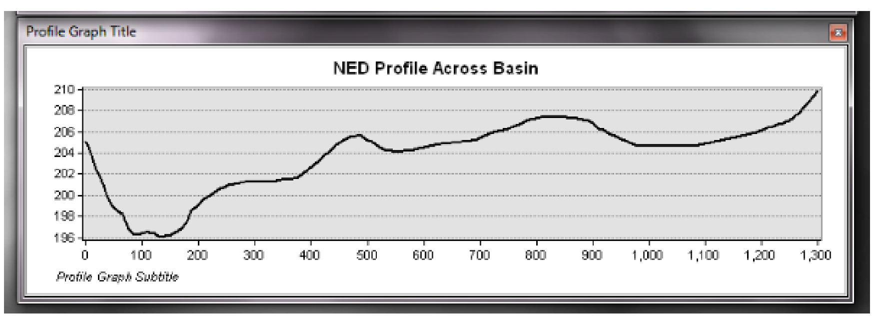


1.2 km length

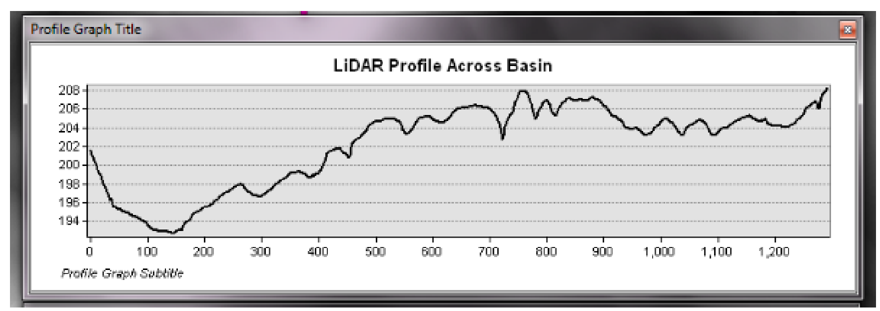
LiDAR



Topo map profile

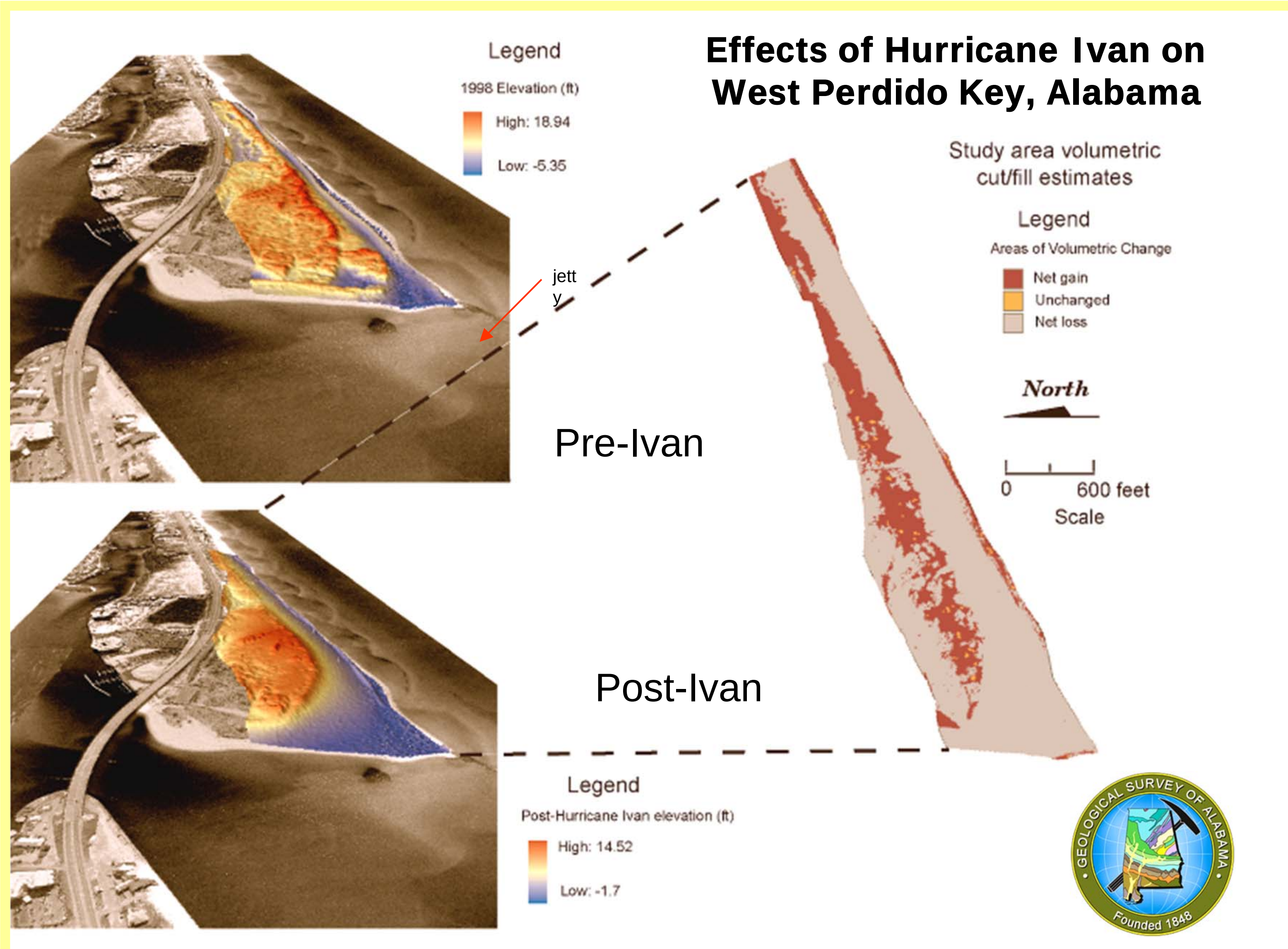


LiDAR profile



Impact to Coast from Hurricane

- Challenges:
  - Identifying shoreline change
  - Calculating sand volume change
    - If needing to rebuild beaches



DEMs of pre-hurricane with post-hurricane LiDAR allows change detection and volume calculation of erosion: how much sand needed for beach restoration

LiDAR Summary

Pros

- XYZ accuracy and detail
- Allows flexibility of final derivatives:
  - DEM resolution and contour interval
- Growing in availability and quality
- Temporally current so it captures:
  - Hazards, roads, anthropogenic features, etc.
- Detailed modeling capabilities
  - Hydrology, geomorphologic characterization, etc.

Cons

- Cost
- Large file size
- Processing
- Knowledge of LiDAR data
- Quality variation across study areas
- Does not come with placenames, roads, etc.

Topographic Map Summary

Pros

- Familiarity
- Anthropogenic features
  - Building footprints
  - Quarries/mines
  - Major roads
- Physical geography
  - Geographic features
- Elegant arrangement of labels /placenames
- Township/Range/Section

Cons

- XYZ errors due to limitations on:
  - Low contour interval
  - Dense forest
- Temporal limitations
  - Although new GeoPDFs have new roads, contours are still the same old lines
- Digital spatial limitations (zoom equal more detail – just larger pixels)
- Densely forested areas may obscure topo features

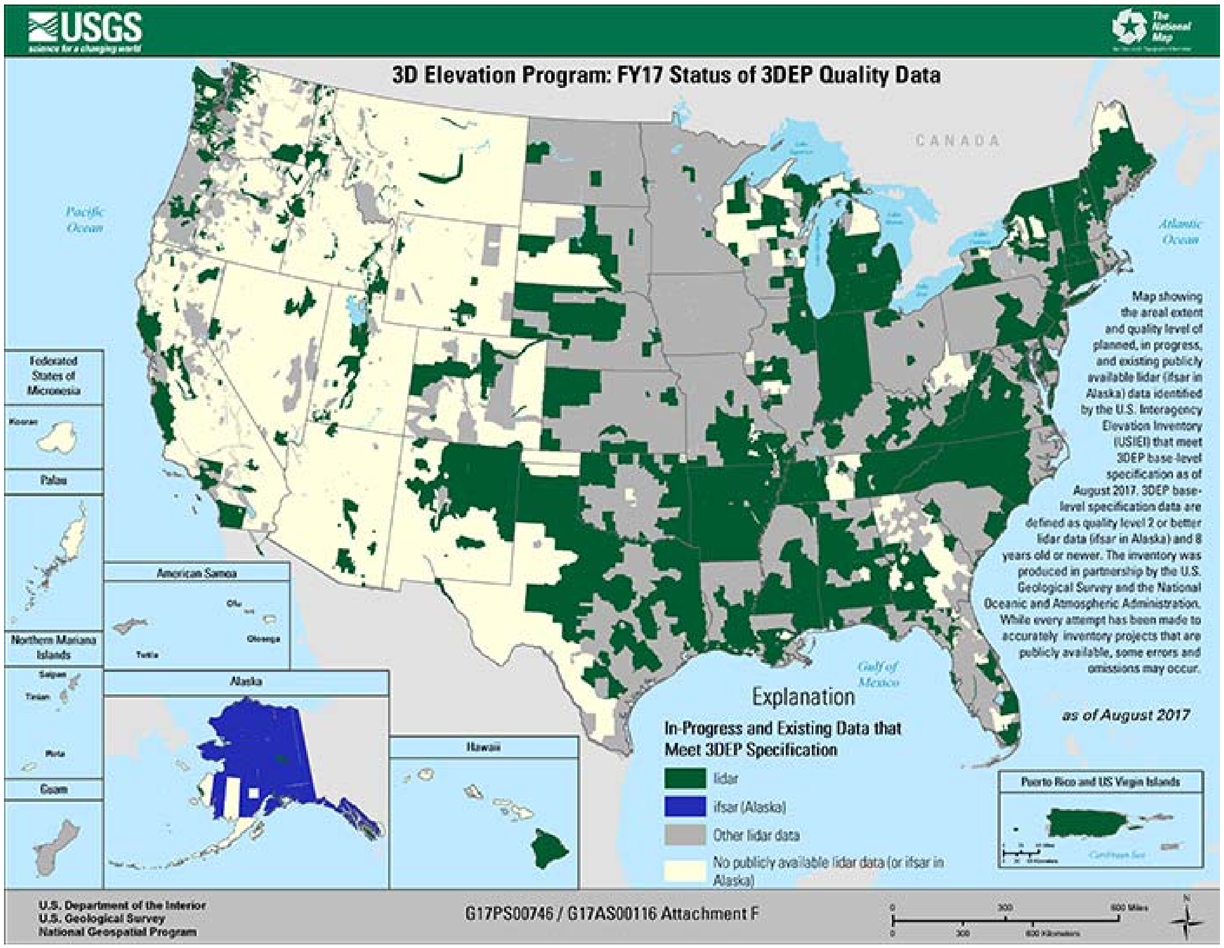
Future: Topo and LiDAR in Geo Mapping

- Tandem approach for geologic mapping
  - Using strengths of each, esp. for pre-field planning
- LiDAR: Generate new contours as a basemap for future quads
  - Many details still to work out…
  - When LiDAR coverage of all STATEMAP areas is available, GSA will begin using LiDAR for generating basemap products for geologic quadrangles

Future LiDAR Plans, Other Projects

- Many GSA projects and activities
  - Hazards
  - Coastal applications
  - Groundwater
  - Ecology
  - Oil/gas
- And as more LiDAR becomes available – more mapping and research use
  - Now 85% of AL counties have LiDAR
  - Thanks in part to USGS 3DEP

USGS 3D Elevation Program (3DEP)



Thank you

- Sandy Ebersole, PhD, PG, GISP
  - Geologic Investigations Program Director
  - sebersole@gsa.state.al.us, 205-247-3613

- Brian Cook, PhD
  - Geologic mapper, Geologic Mapping Section
  - bcook@gsa.state.al.us, 205-247-3669

References of Interest

- History of topographic mapping, USGS
  - https://nationalmap.gov/ustopo/125history.html
- LiDAR publications, USGS
  - https://www.usgs.gov/science-explorer-results?es=LiDAR
- National Map program, 3DEP website, USGS
  - https://nationalmap.gov/3DEP/
- Geological Survey of Alabama
  - http://www.gsa.state.al.us