

# Management and Use of LiDAR-derived Information

Elizabeth Cook, GIS Specialist



# Now What?

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50-100 gb/county

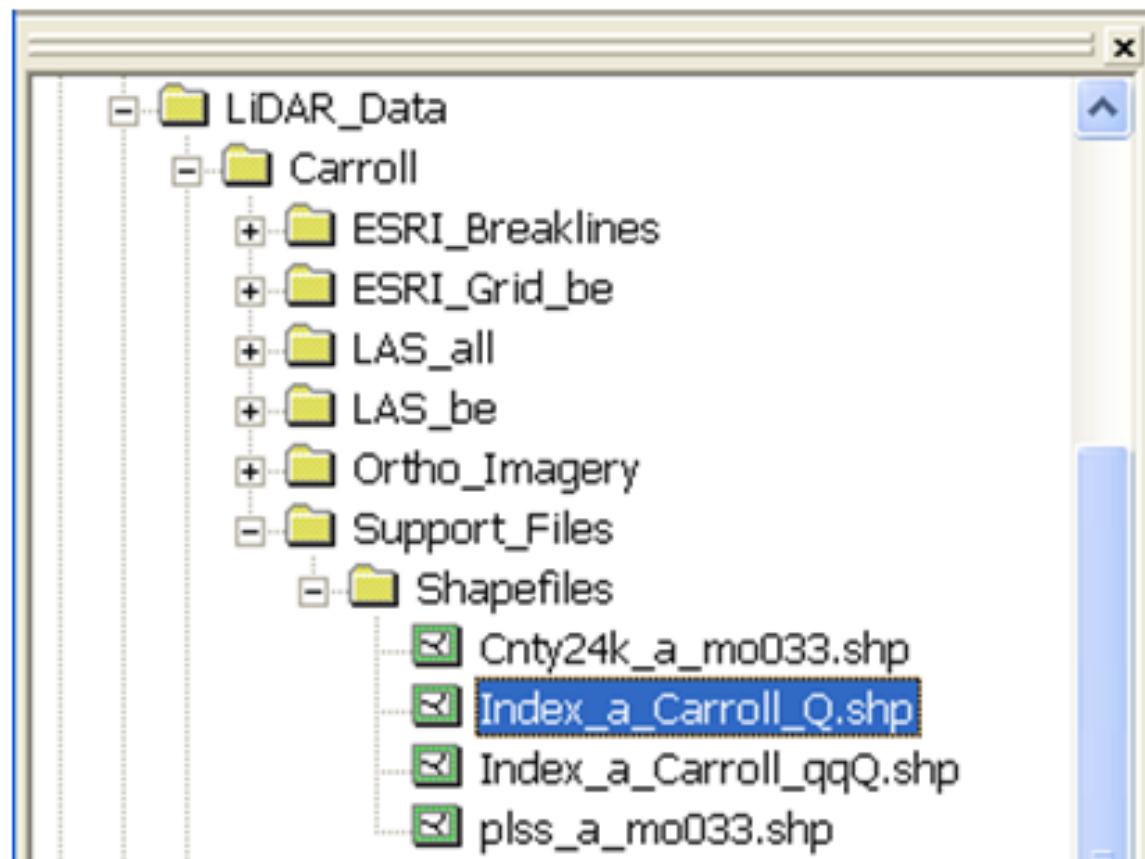
# Project Deliverables

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- LAS mass point files, classification of points to contract specifications
- Raster (ESRI Grid, .img or other) bare-earth DEMs, per tiling schema
- Control points for independent vertical QA
- Misc – tile indexes, breaklines, QA reports, metadata files

# LiDAR Index

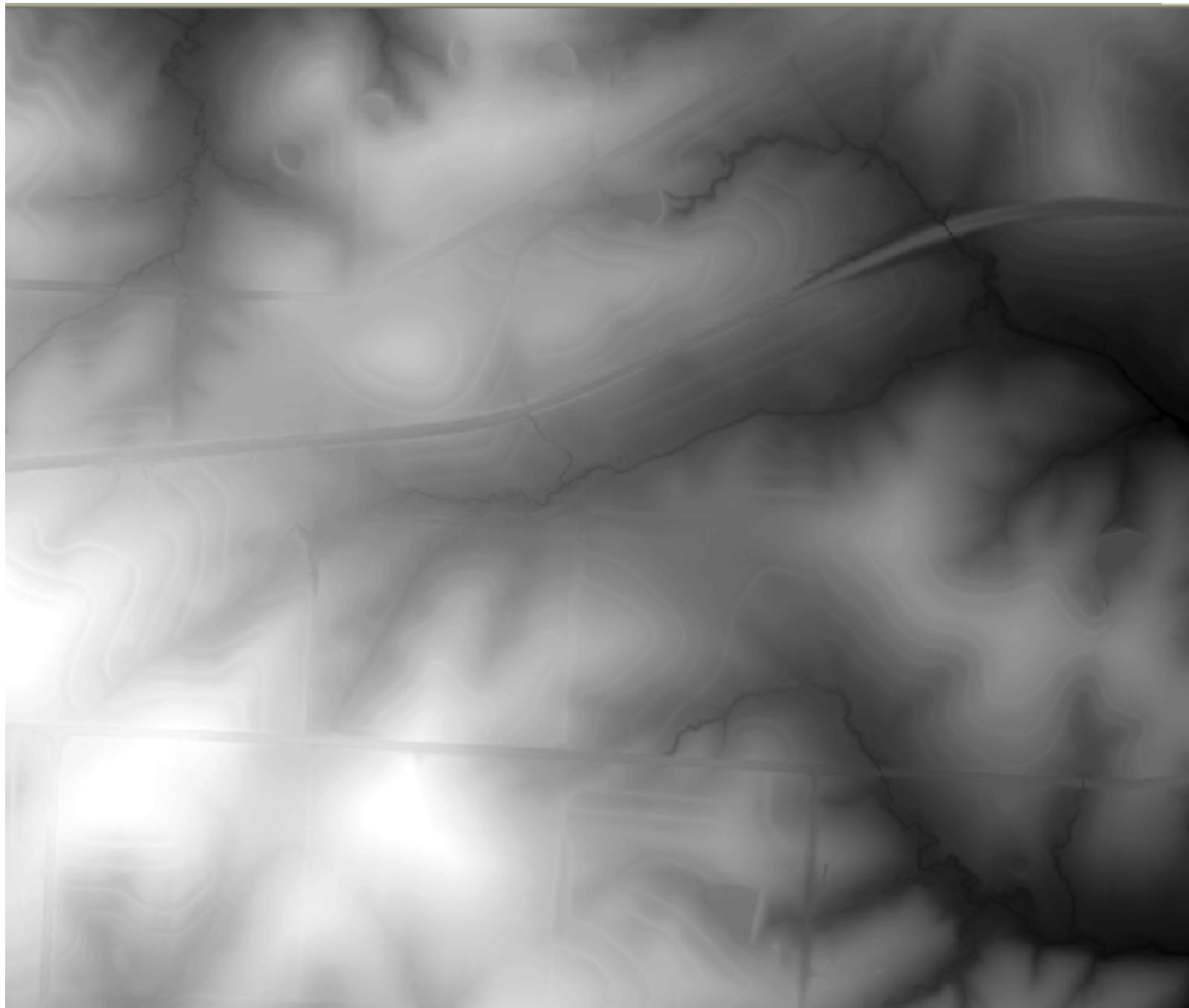
*Figure 2: ArcMap Index Project Location*

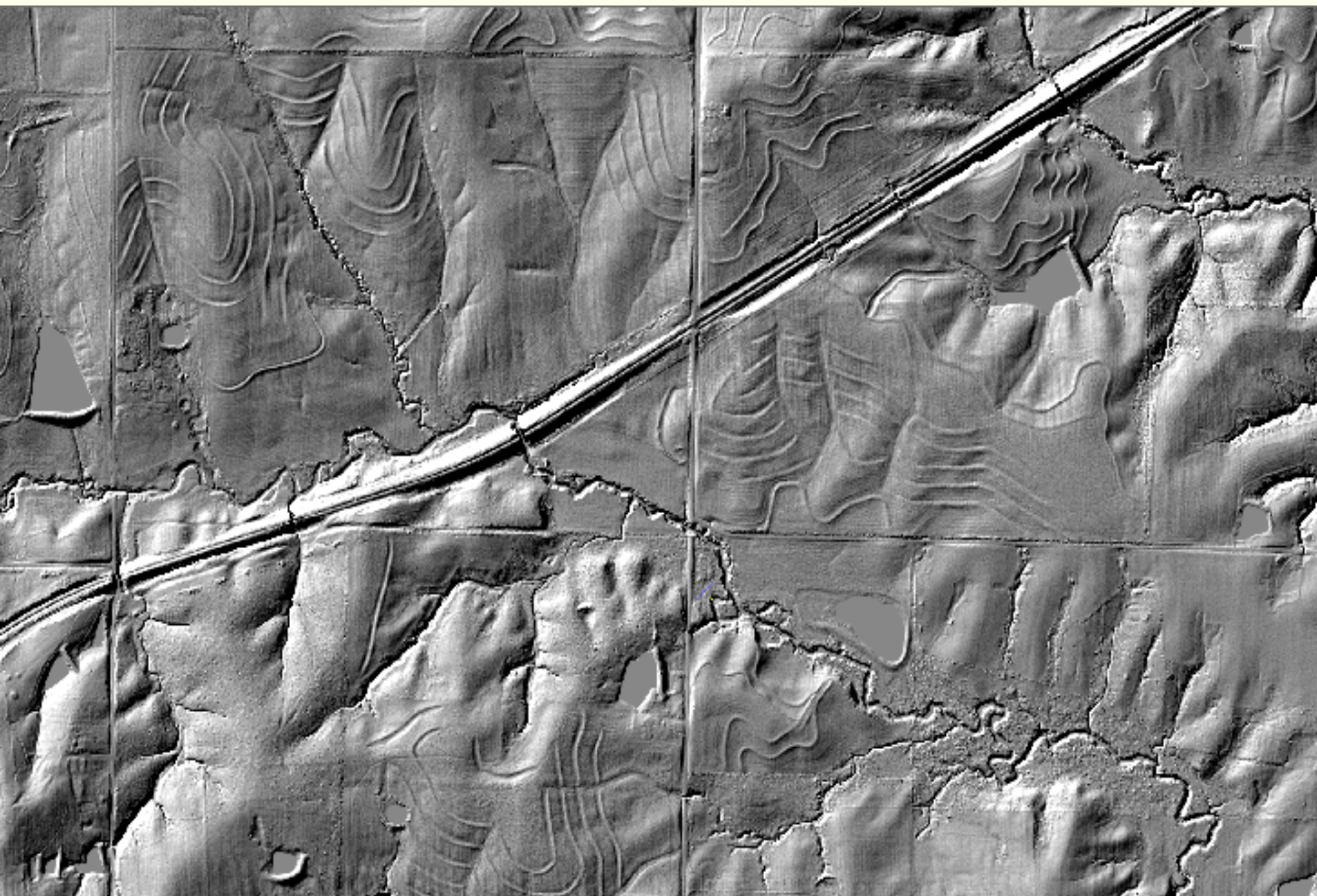


# LiDAR Products for Users

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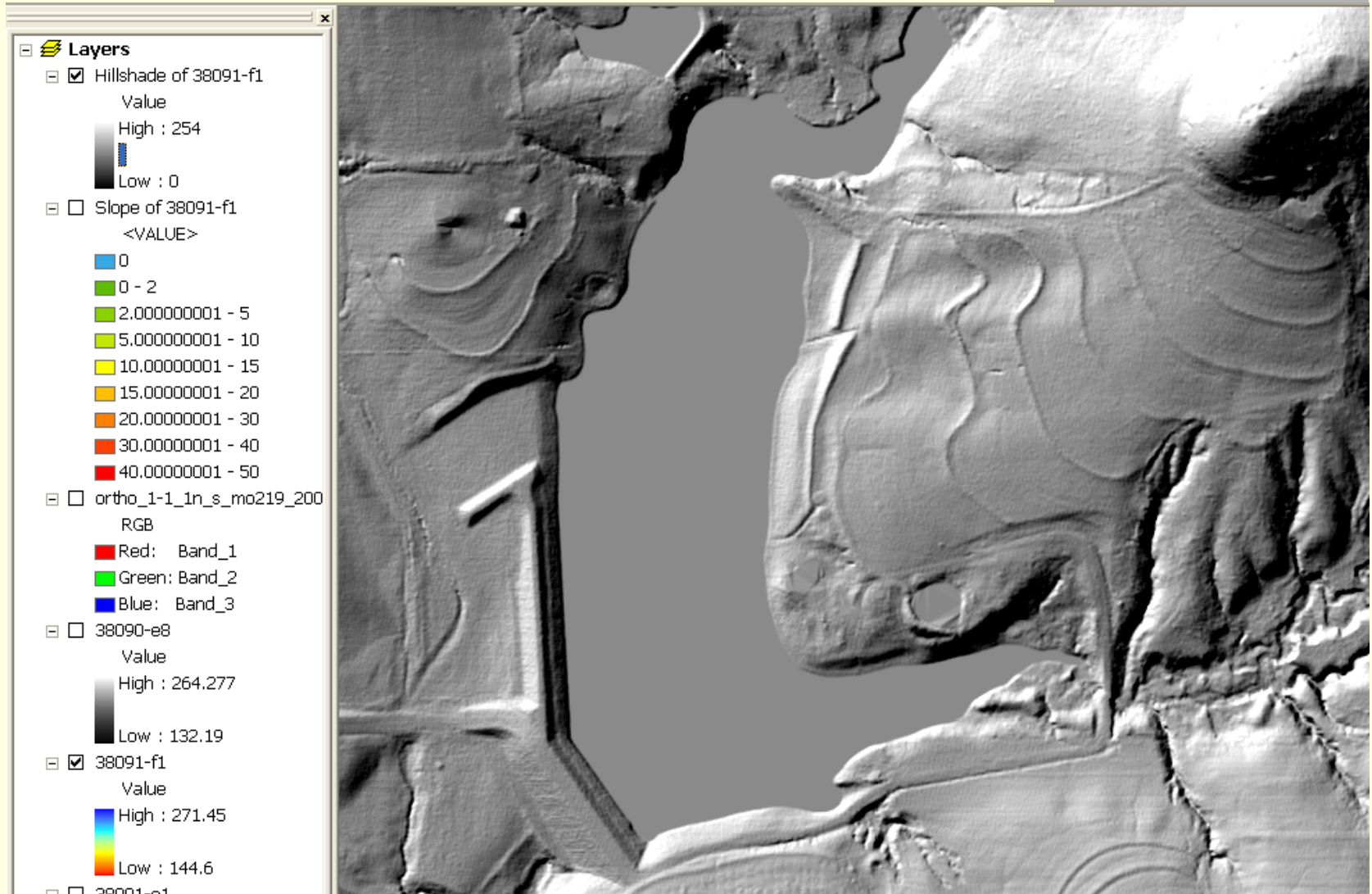
- Elevation Models (DEMs\* or TINs)
  - Relief (Hillshade) Maps \*
  - Contour Maps
  - Slope Maps
  - Aspect Maps
- 
- LAS files for first-return processing\*



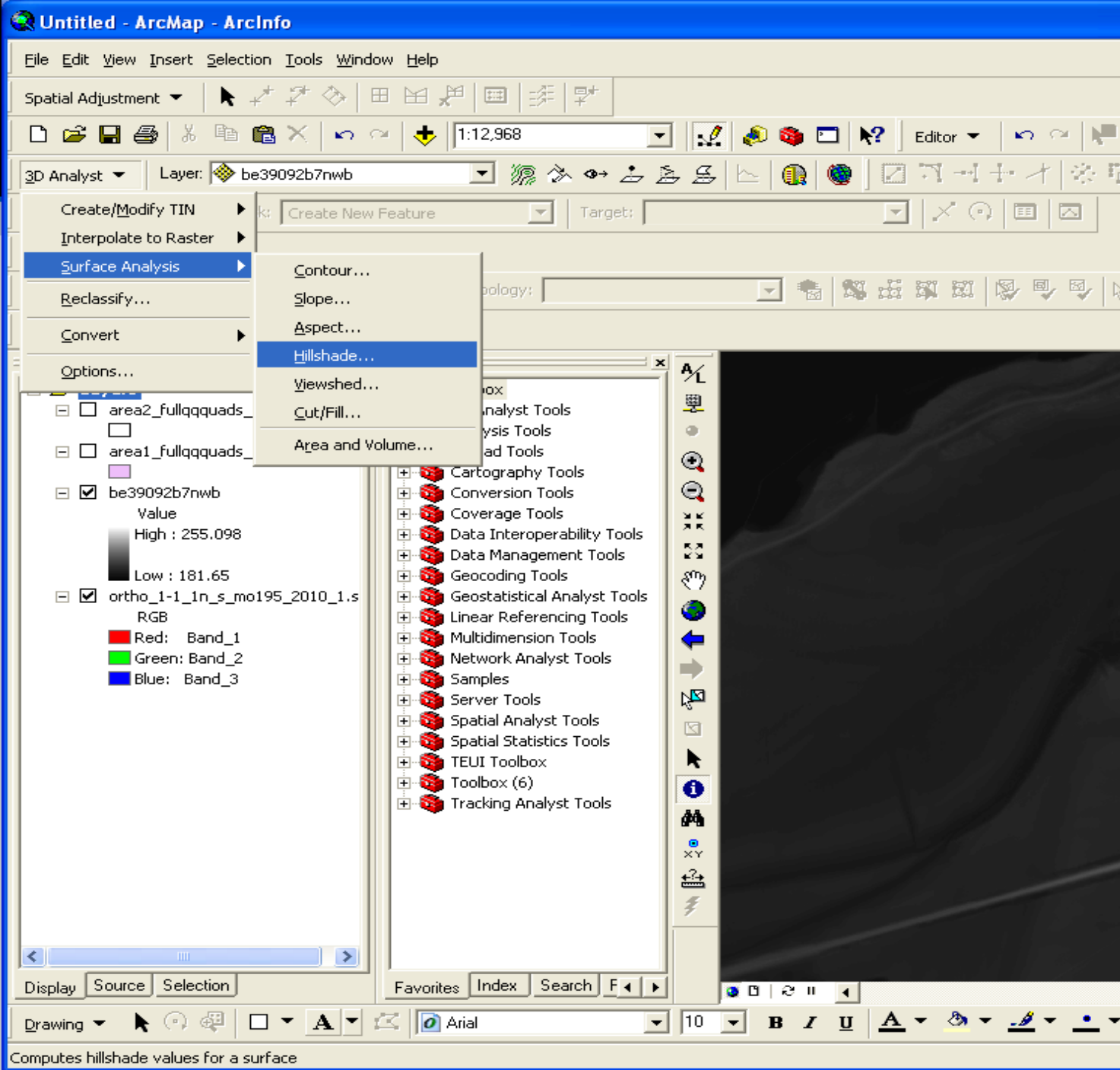




# LiDAR Products - Hillshades







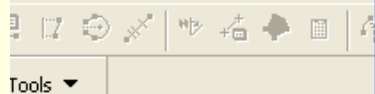
Adjustment



alyst Layer: be39092b7nwb

Task: Create New Feature

Target:



Tools

## Layers

- ☐ area2\_fullqqquads\_delivery
- ☐ area1\_fullqqquads\_delivery
- ☒ Hillshade of be39092b7nwb
  - Value
  - High : 254
  - Low : 0
- ☒ be39092b7nwb
  - Value
  - High : 255.098
  - Low : 181.65
- ☒ ortho\_1-1\_in\_s\_mo195\_2010\_1.s
  - RGB
  - Red: Band\_1
  - Green: Band\_2
  - Blue: Band\_3

## Layer Properties

General Source Extent Display Symbology Fields Joins &amp; Relates

Show:

- Unique Values
- Classified
- Stretched

## Draw raster stretching values along a color ramp

Import...

Color



Value

254

Label

High : 254

Edit High/Low Values

☐

0

Low : 0

Color Ramp:

☐ Display Background Value:

0

as

☐ Use hillshade effect

Z:

1

Display NoData as

Stretch

Type:

Minimum-Maximum

None

Custom

Standard Deviations

Histogram Equalize

Minimum-Maximum

Histogram Specification

Histograms...

☐ Invert

OK

Cancel

Apply



## Layers

- ☐ area2\_fullqqquads\_delivery
- ☐ area1\_fullqqquads\_delivery
- ☒ Hillshade of be39093b7
  - Value
  - High : 254
  - Low : 0
- ☒ be39093b7
  - Value
  - High : 271.759
  - Low : 203.81
- ☒ ortho\_1-1\_in\_s\_mo195\_2010\_1.s

### Layer Properties

General Source Extent Display Symbology Fields Joins & Relates

Show: Classified Stretched

Draw raster stretching values along a color ramp Import...

Color	Value	Label
	271.759399	High : 271.759
	203.809998	Low : 203.81

Color Ramp:

☐ Display Background Value: 0 as

☐ Use hillshade effect Z: 1 Display NoData as

Stretch

Type: Standard Deviations Histograms...

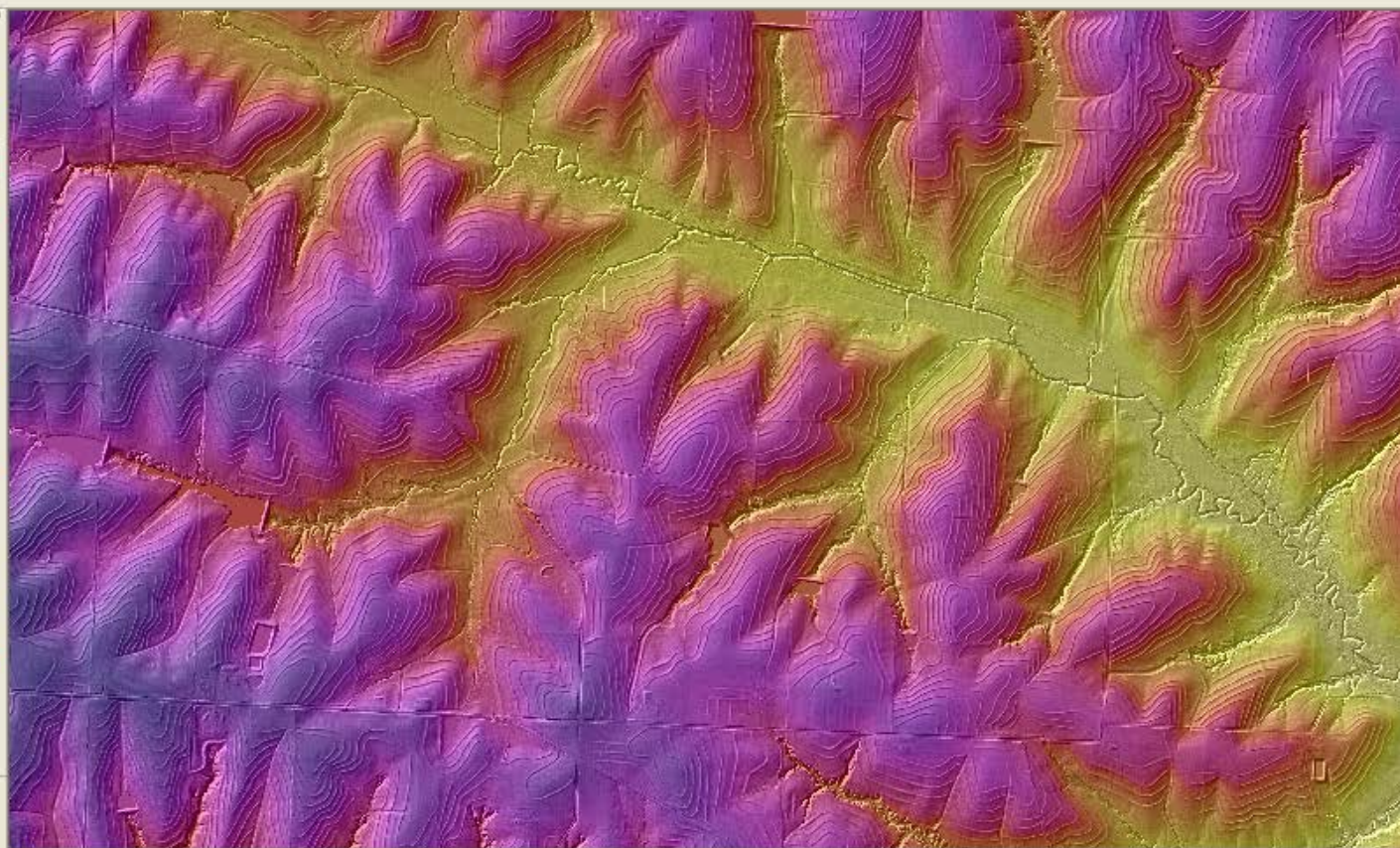
n: 2 ☐ Invert

OK Cancel Apply



**Layers**

- ☐ area2\_fullqqquads\_delivery
- ☐ area1\_fullqqquads\_delivery
- ☒ be39093b7
  - Value
  - High : 271.759
  - Low : 203.81
- ☒ Hillshade of be39093b7
  - Value
  - High : 254
  - Low : 0
- ☒ ortho\_1-1\_1n\_s\_mo195\_2010\_1.s



# Layers

- ☐ area2\_fullqqquads\_delivery
- ☐ area1\_fullqqquads\_delivery
- ☒ be39093b7
  - Value
  - High : 271.759
  - Low : 203.81
- ☒ Hillshade of be39093b7
  - Value
  - High : 254
  - Low : 0
- ☒ ortho\_1-1\_1n\_s\_mo195\_2010\_1.s

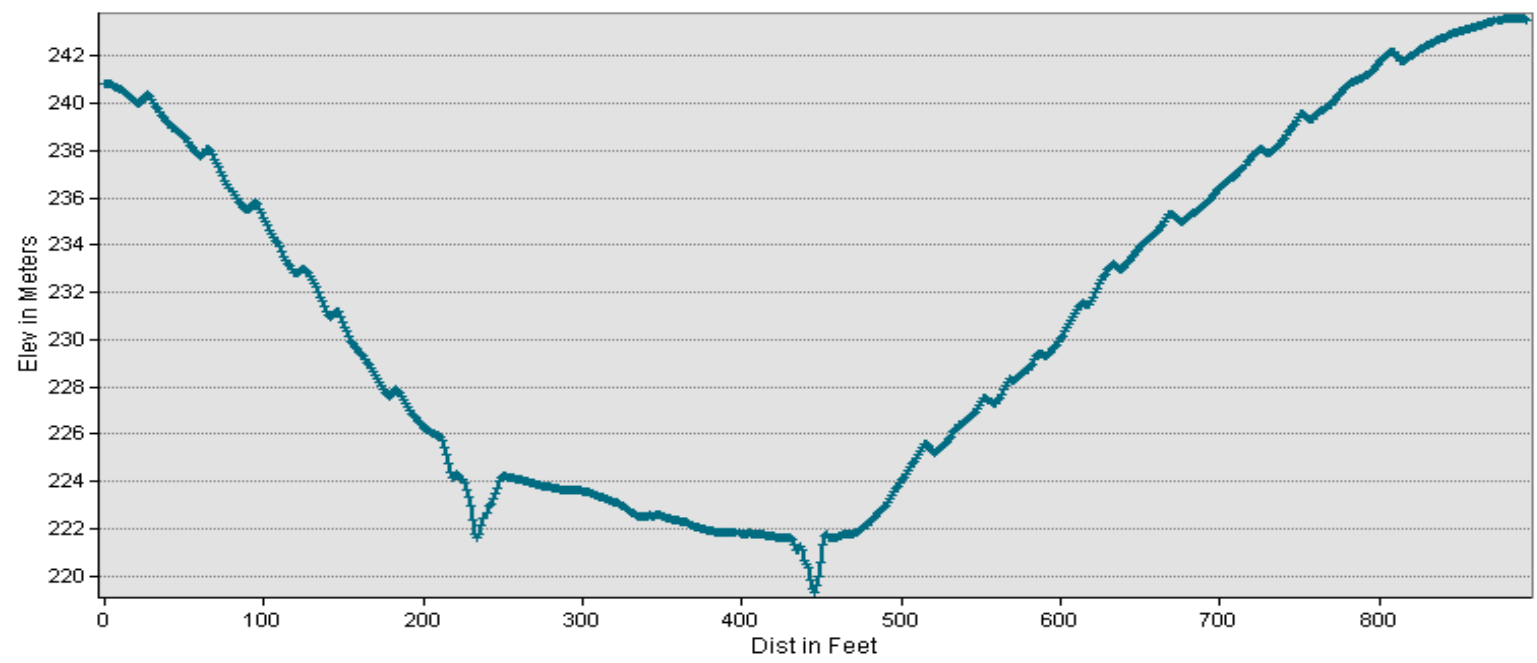
# ArcToolbox

- 3D Analyst Tools
  - Conversion
  - Functional Surface
  - Raster Interpolation
  - Raster Math
  - Raster Reclass
  - Raster Surface
  - Terrain
  - TIN Creation
    - Create TIN
    - Delineate TIN Dat
    - Edit TIN
  - TIN Surface
- Analysis Tools
- ArcPad Tools
- Cartography Tools
- Conversion Tools
- Coverage Tools
- Data Interoperability Too
- Data Management Tools
- Geocoding Tools
- Geostatistical Analyst Toc
- Linear Referencing Tools
- Multidimension Tools
- Network Analyst Tools
- Samples
- System Tools



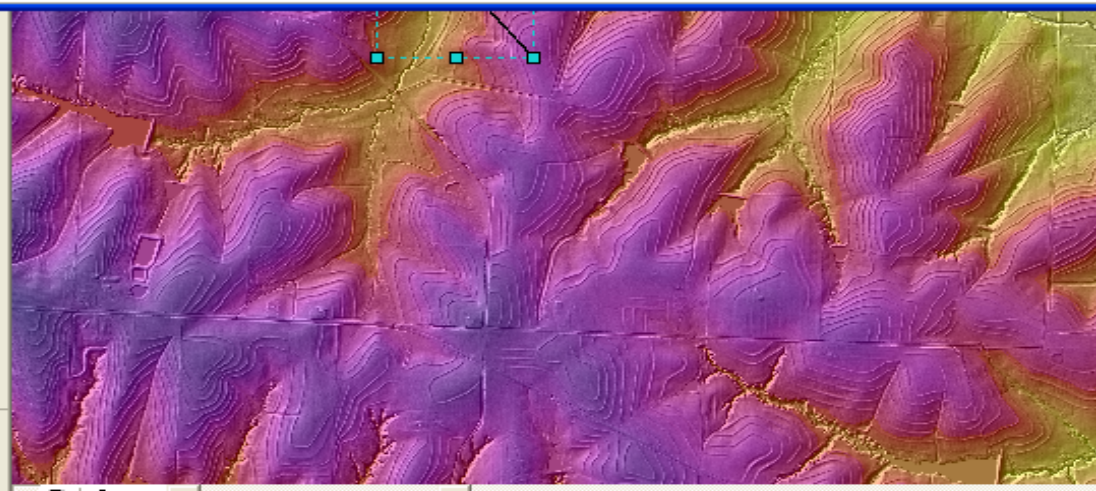
Profile Graph Title

Valley Cross-Section



Profile Graph Subtitle

- Analysis Tools
- ArcPad Tools
- Cartography Tools
- Conversion Tools
- Coverage Tools
- Data Interoperability Tools
- Data Management Tools
- Geocoding Tools
- Geostatistical Analyst Tools
- Linear Referencing Tools
- Multidimension Tools
- Network Analyst Tools
- Samples
- Survey Tools





File Edit View Insert Selection Tools Window Help

Spatial Adjustment

1:27,586 Editor

3D Analyst Layer: be39093b7

Editor Task: Create New Feature Target:

Topology:

Utility Tools

**Layers**

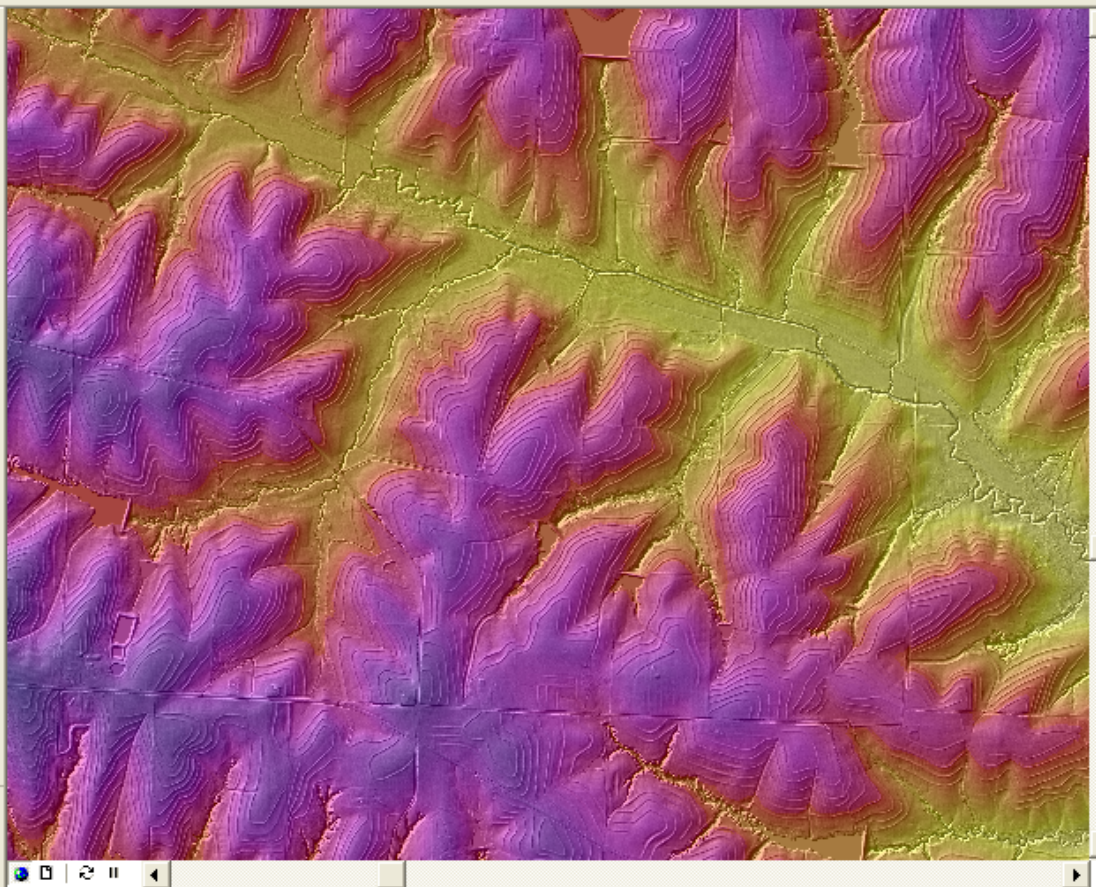
- ☐ area2\_fullqqquads\_delivery
- ☐ area1\_fullqqquads\_delivery
- ☒ be39093b7
  - Value
  - High : 271.759
  - Low : 203.81
- ☒ Hillshade of be39093b7
  - Value
  - High : 254
  - Low : 0
- ☒ ortho\_1-1\_1n\_s\_mo195\_2010\_1.s

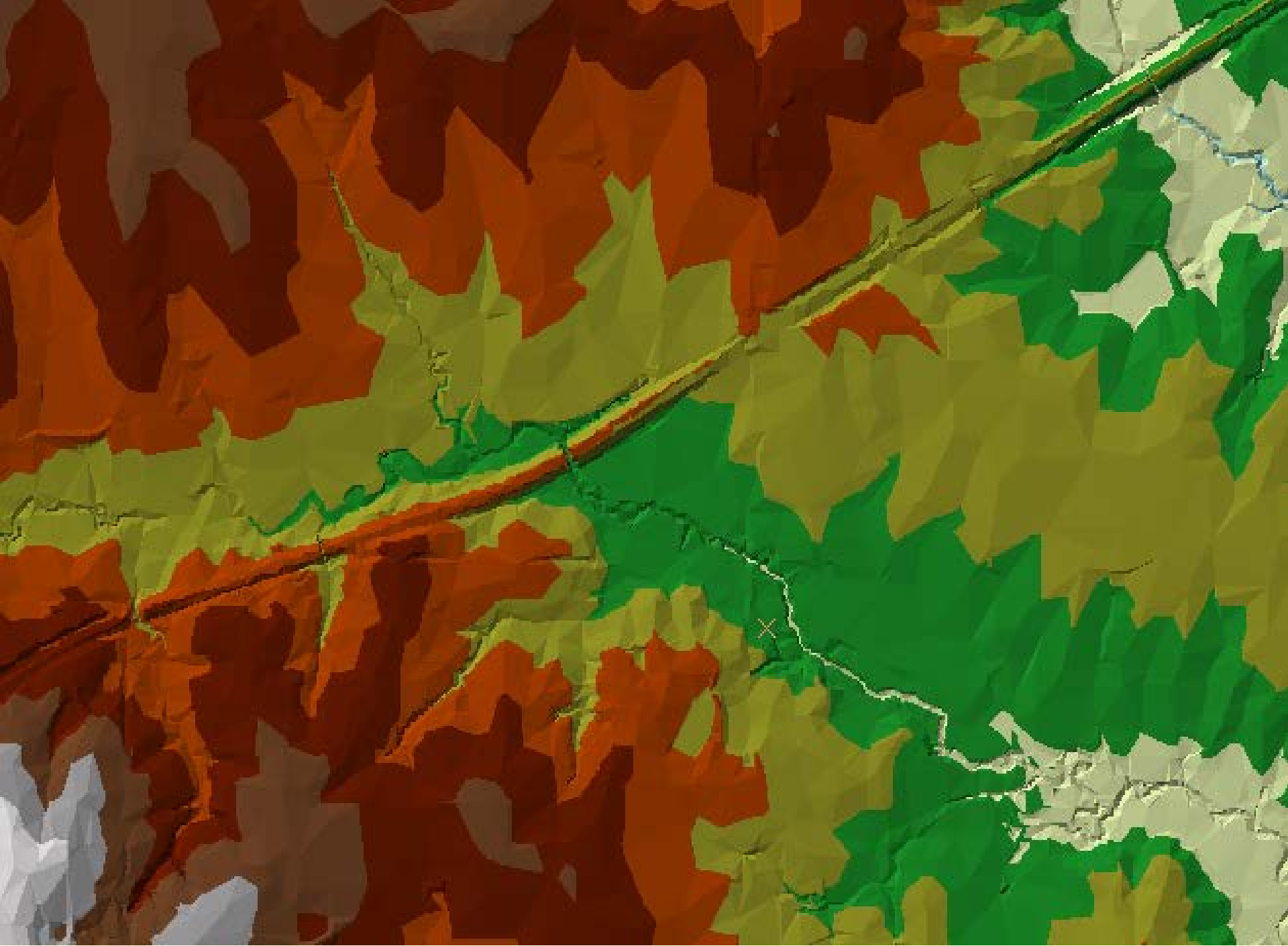
Display Source Selection

**ArcToolbox**

- 3D Analyst Tools
  - Conversion
  - Functional Surface
  - Raster Interpolation
  - Raster Math
  - Raster Reclass
  - Raster Surface
  - Terrain
    - TIN Creation**
      - Create TIN**
      - Delineate TIN Data
      - Edit TIN
  - TIN Surface
- Analysis Tools
- ArcPad Tools
- Cartography Tools
- Conversion Tools
- Coverage Tools
- Data Interoperability Tools
- Data Management Tools
- Geocoding Tools
- Geostatistical Analyst Tools
- Linear Referencing Tools
- Multidimension Tools
- Network Analyst Tools
- Samples
- System Tools

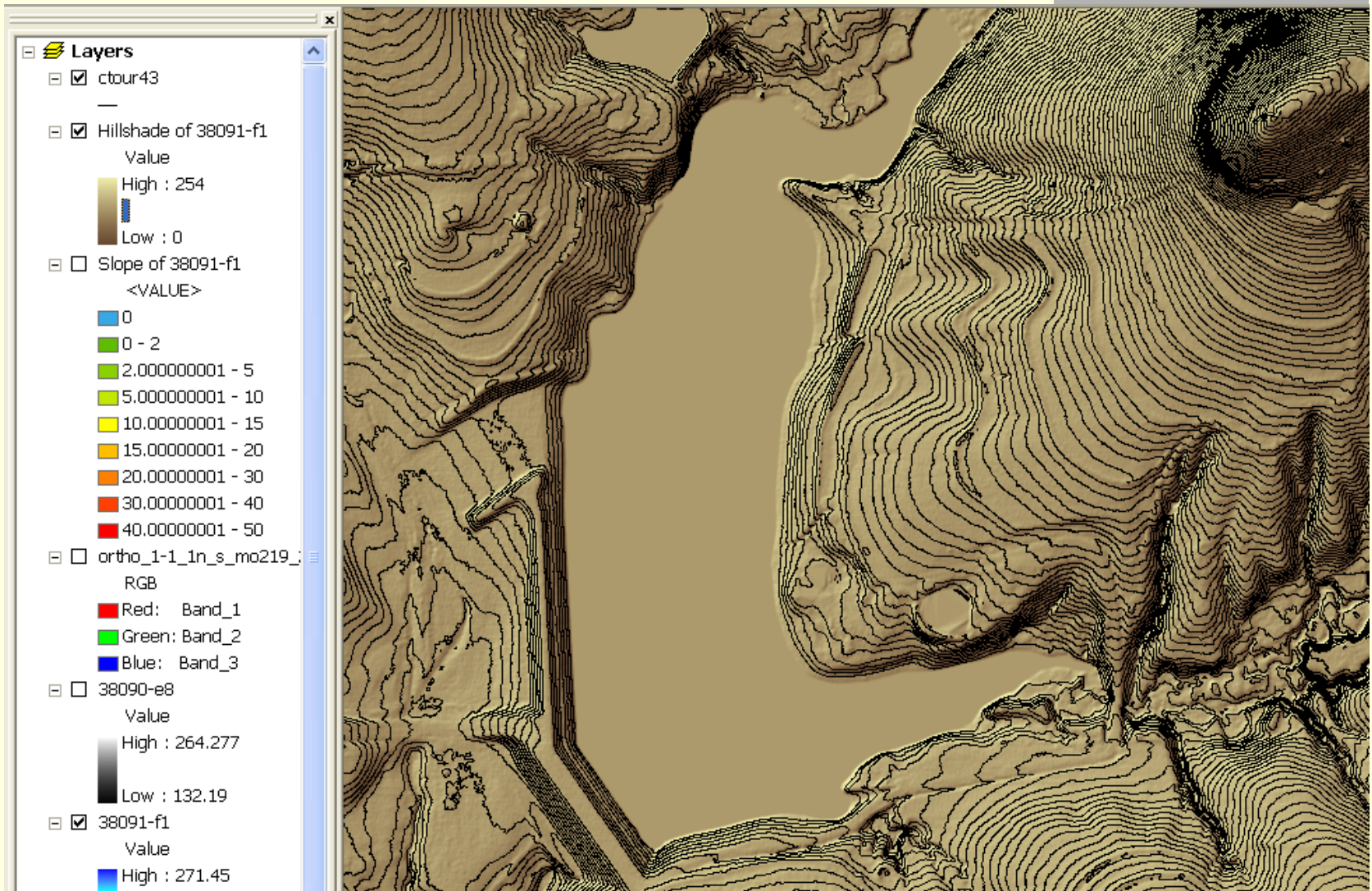
Favorites Index Search

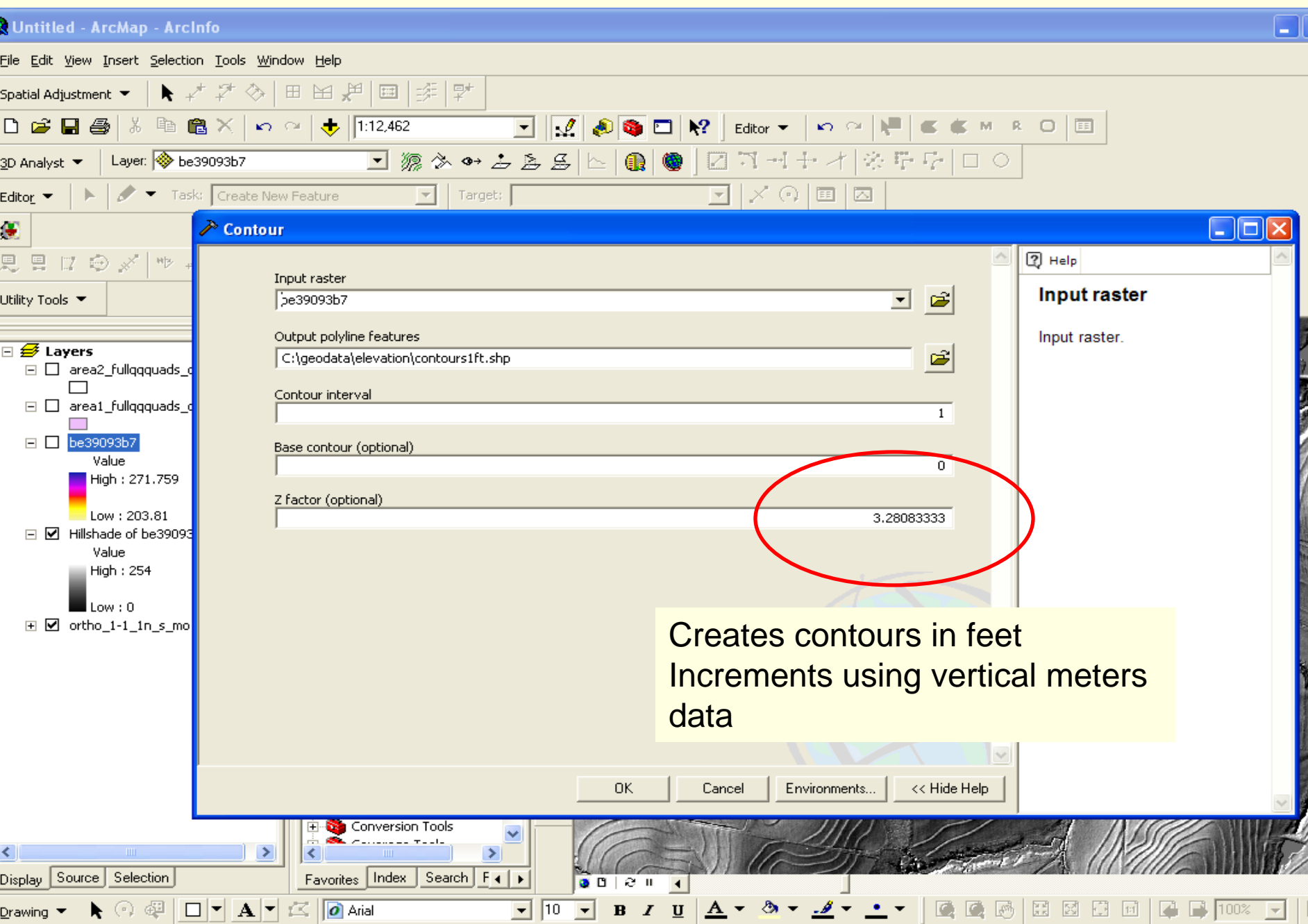






# LiDAR Products - Contours





File Edit View Insert Selection Tools Window Help

Spatial Adjustment

3D Analyst Layer: be39093b7

Editor Task: Create New Feature Target:

Topology:

Utility Tools

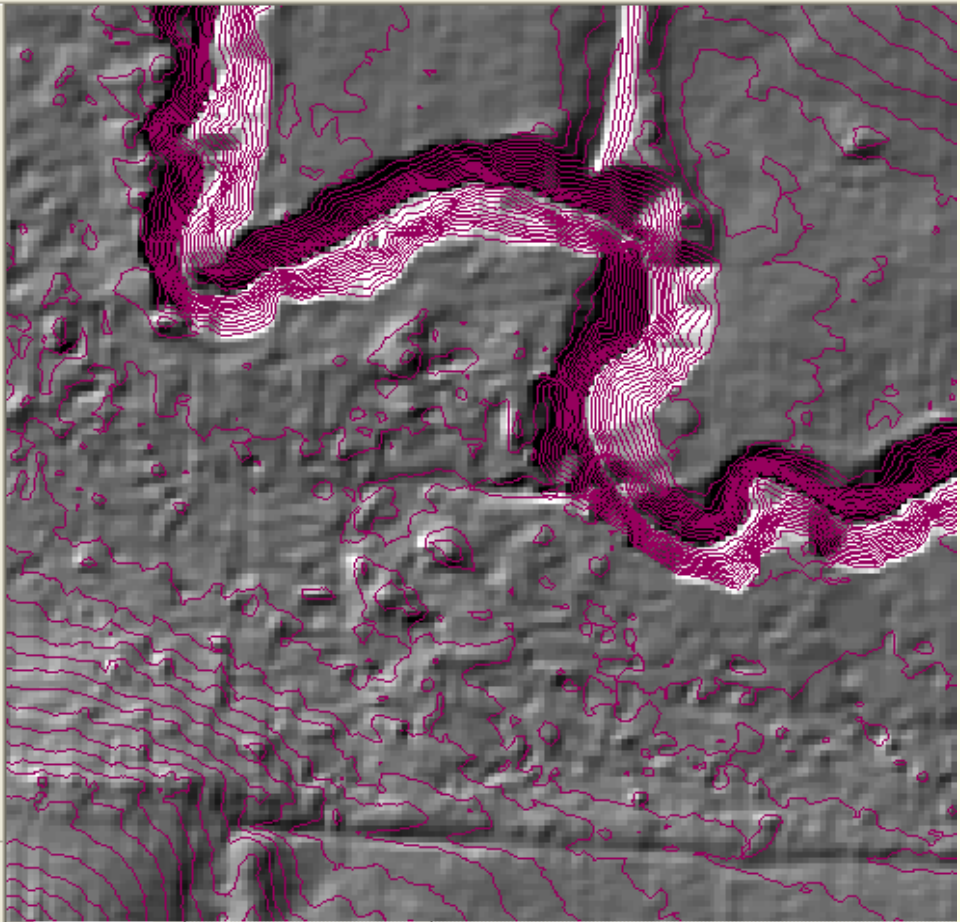
**Layers**

- ☒ contours1ft
- ☐ area2\_fullqqquads\_delivery
- ☐ area1\_fullqqquads\_delivery
- ☐ be39093b7
  - Value
  - High : 271.759
  - Low : 203.81
- ☒ Hillshade of be39093b7
  - Value
  - High : 254
  - Low : 0
- ☒ ortho\_1-1\_1n\_s\_mo195\_2010\_1.s

**ArcToolbox**

- 3D Analyst Tools
  - Conversion
  - Functional Surface
  - Raster Interpolation
  - Raster Math
  - Raster Reclass
  - Raster Surface
    - Aspect
    - Contour
    - Contour List
    - Curvature
    - Cut/Fill
    - Hillshade
    - Observer Points
    - Slope
    - Viewshed
- Terrain
  - TIN Creation
    - Create TIN
    - Delineate TIN Dat
    - Edit TIN
  - TIN Surface
- Analysis Tools
- ArcPad Tools
- Cartography Tools
- Conversion Tools

Ortho\_1-1\_1n\_s\_mo195\_2010\_1.s



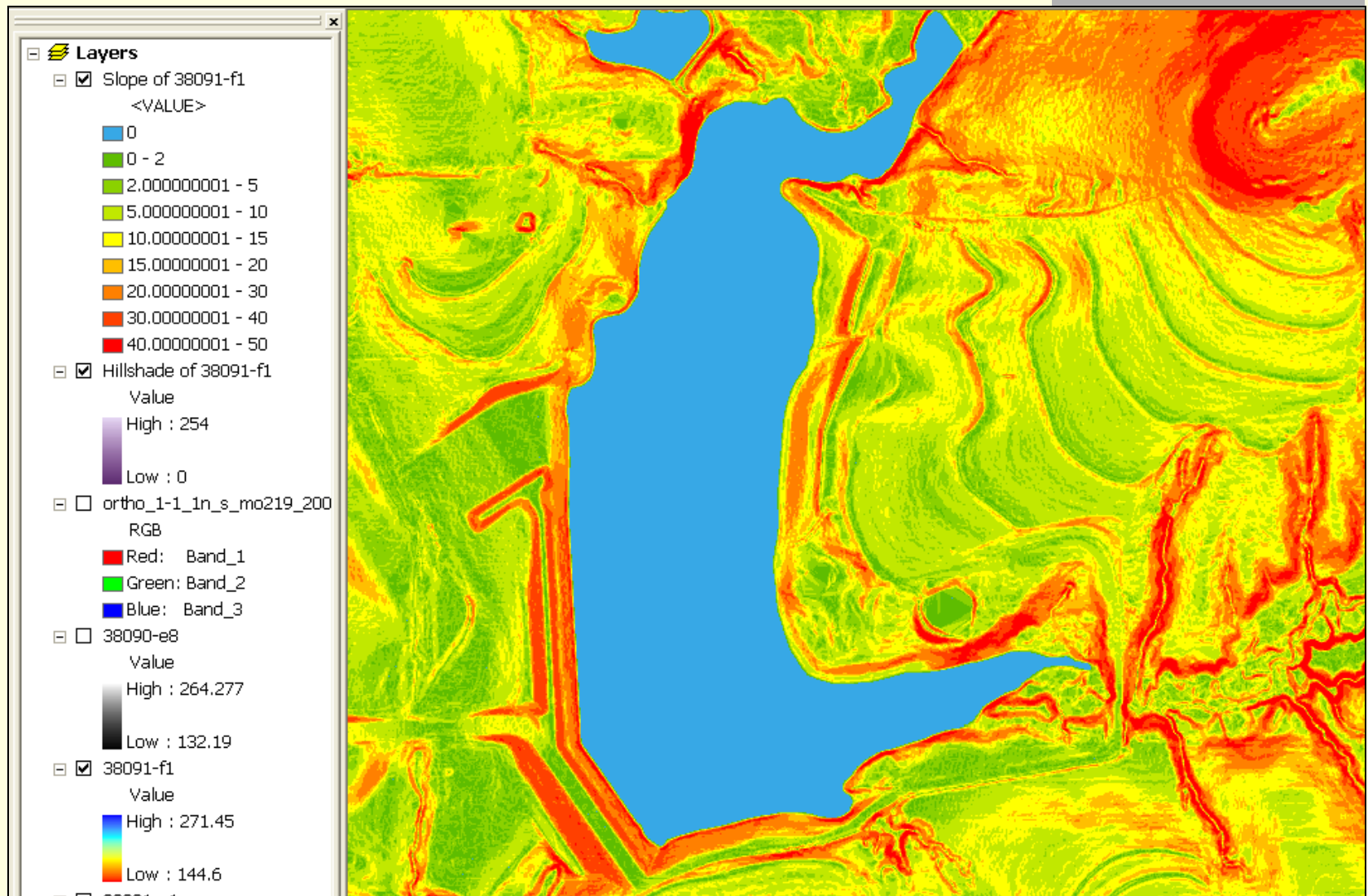
# Considerations for Making Contours

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- Smooth DEM using Focal Statistics – Mean
- Produce contours for relatively small areas; algorithm prone to crashing or locking up on large areas
- Encourage use of raster elevation tools

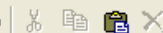


# LiDAR Products – Land Slopes



File Edit View Insert Selection Tools Window Help

Spatial Adjustment



Editor



3D Analyst

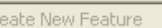
Layer: dem2cad



Editor



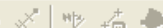
Task: Create New Feature



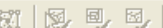
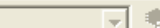
Target:



Utility Tools



Topology:



Layers

☒ symbology\_test



☒ t901



☒ dem2cad

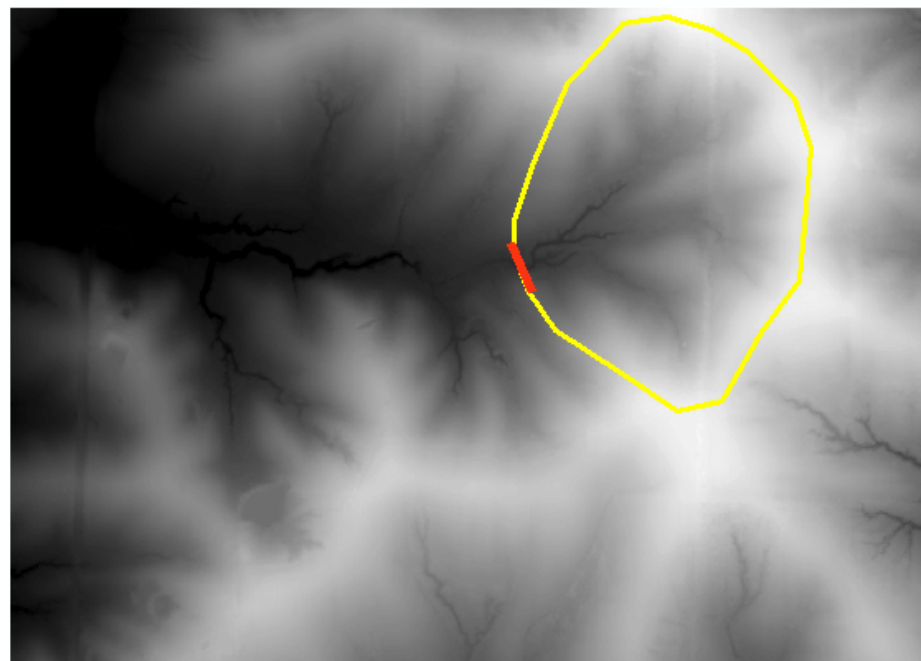
Value

High : 234.607

Low : 205.331

ArcToolbox

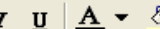
- 3D Analyst Tools
- Analysis Tools
- ArcPad Tools
- Cartography Tools
- Conversion Tools
- Coverage Tools
- Data Interoperability Tools
- Data Management Tools
- Geocoding Tools
- Geostatistical Analyst Tools
- Linear Referencing Tools
- Multidimension Tools
- Network Analyst Tools
- Samples
- Server Tools
- Spatial Analyst Tools
- Spatial Statistics Tools
- TEUI Toolbox
- Toolbox (6)
- Tracking Analyst Tools



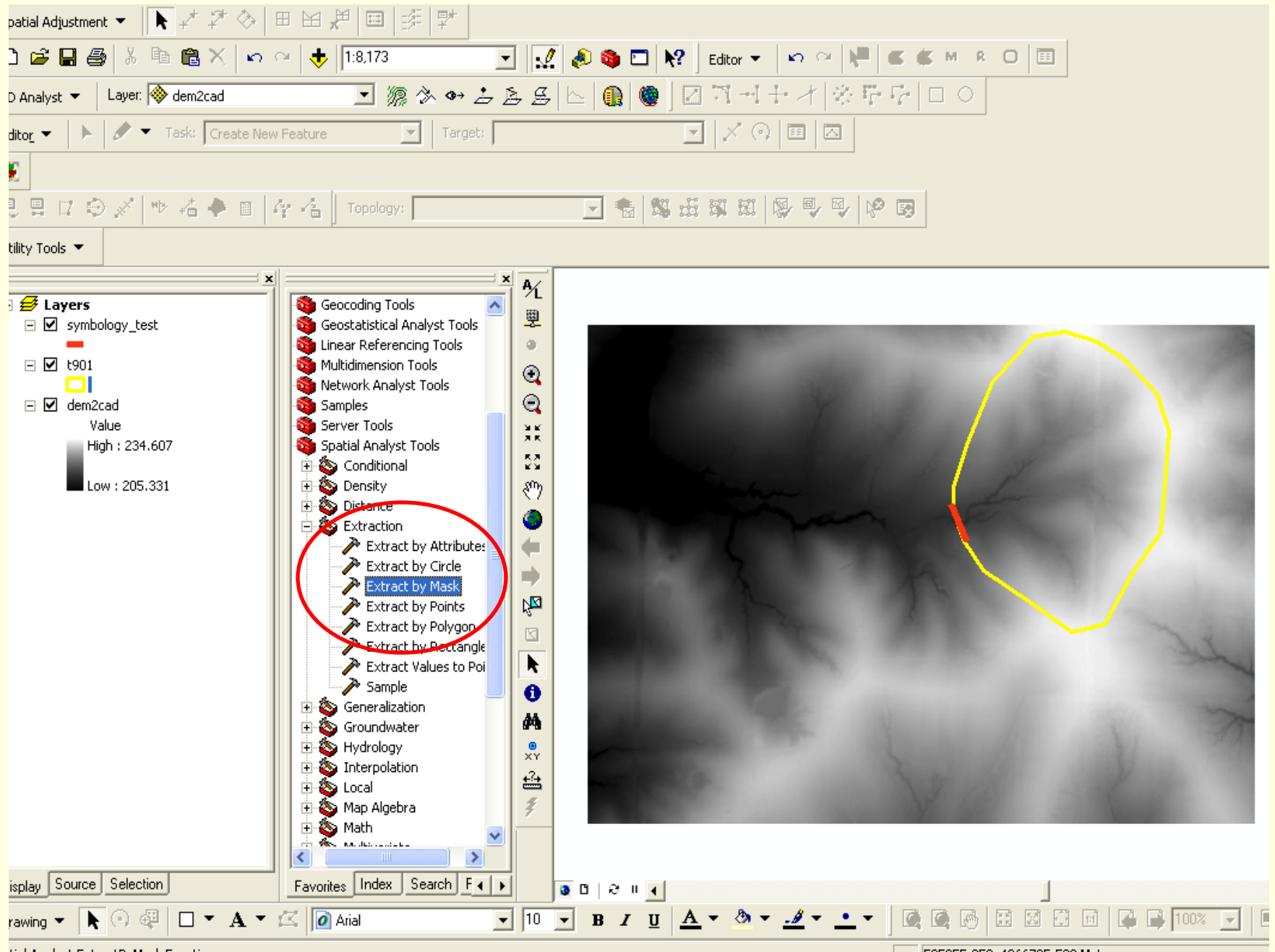
Display Source Selection

Favorites Index Search

Drawing



525118.56 4367002.299 Meters



Spatial Adjustment

1:8,173

Layer: dem2cad

Task: Create New Feature

Target:

## Slope

Input raster

dadem

Output raster

C:\geodata\elevation\Slope\_dadem1

Output measurement (optional)

PERCENT\_RISE

Z factor (optional)

1

OK

Cancel

Environments...

<< Hide Help

Help

## Input raster

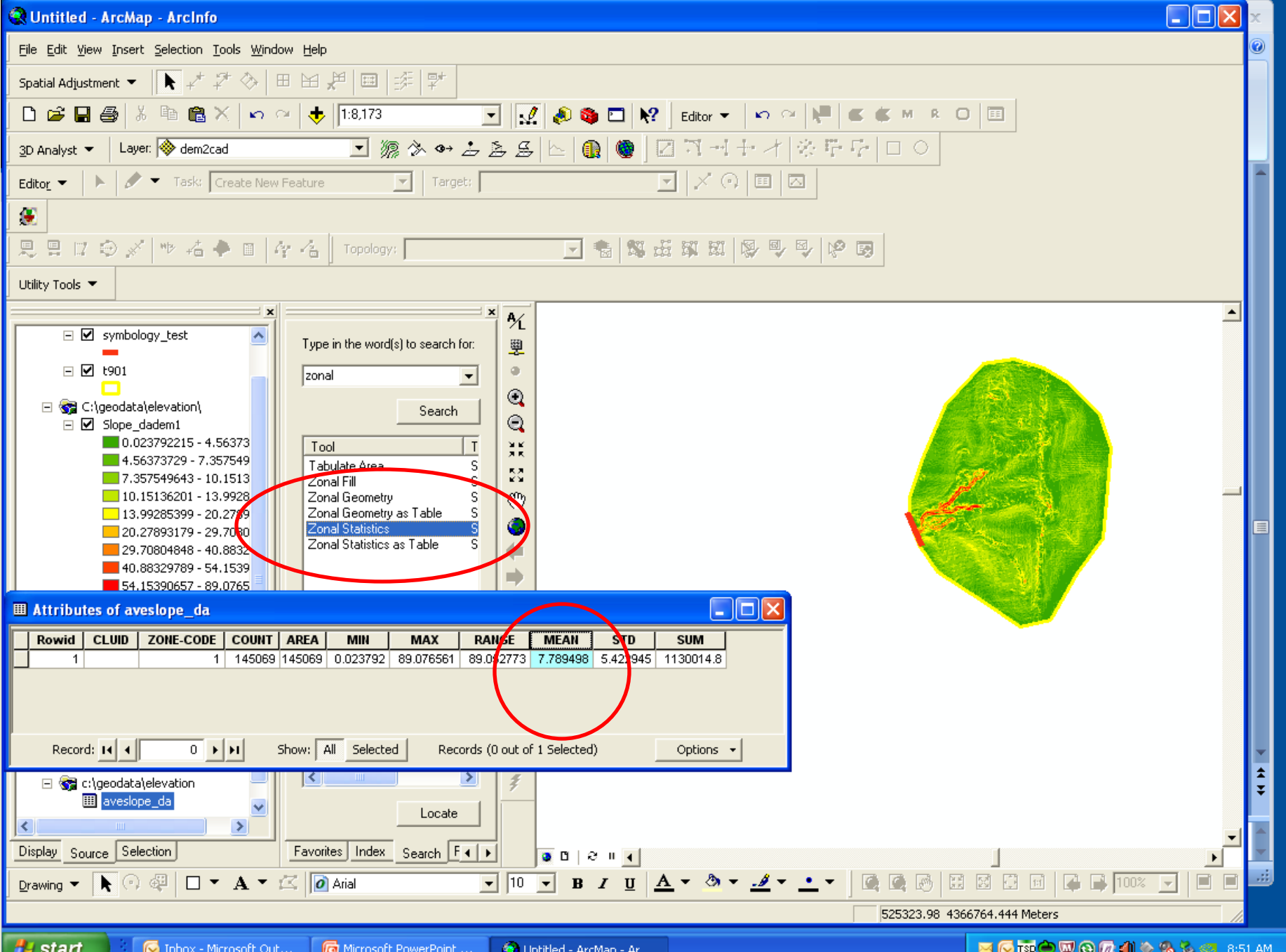
Input raster.

## Layers

- ☒ symbology\_test
- ☒ t901
- ☒ dadem
  - Value
  - High : 234.482
  - Low : 216.569
- ☐ dem2cad
  - Value
  - High : 234.607
  - Low : 205.331

Display Source Selection

Favorites Index Search



# LiDAR Products for Users

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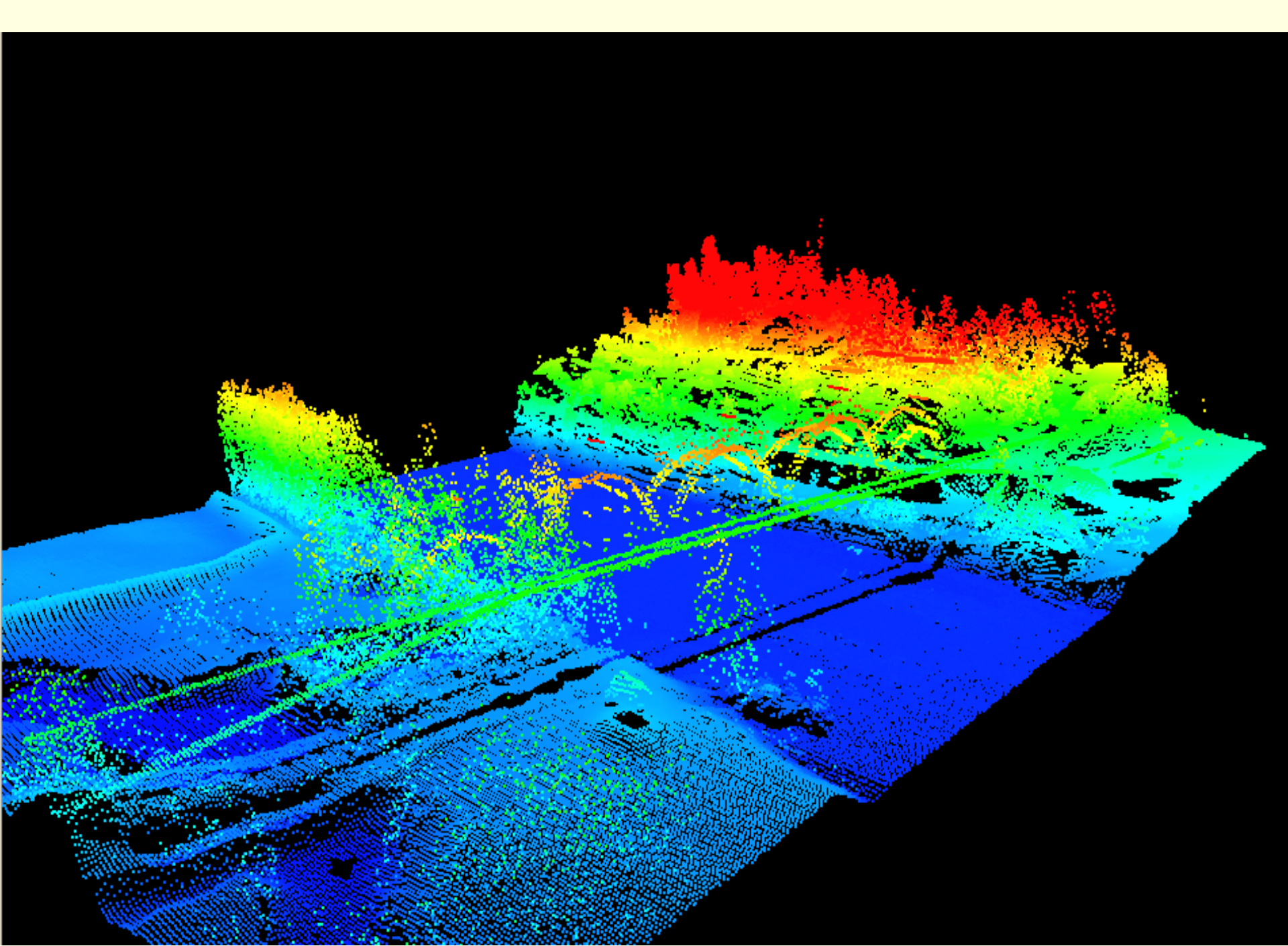
- Elevation Models (DEMs\* or TINs)
- Relief (Hillshade) Maps \*
- Contour Maps
- Slope Maps
- Aspect Maps
- LAS files for first-return processing\*



# LAS Classifications

<u>Classification Codes</u>	<u>Class</u>
0	Created, never classified
1	Unclassified
2	Ground
3	Low Vegetation
4	Medium Vegetation
5	High Vegetation
6	Building
7	Low Point (noise)
8	Model Key-point (mass point)
9	Water
10	Reserved for ASPRS Definition
11	Reserved for ASPRS Definition
12	Overlap Points
13-31	Reserved for ASPRS Definition
32-255	Not reserved currently

\*Source: *LAS Specification, Version 1.1 ([www.lasformat.org](http://www.lasformat.org))*

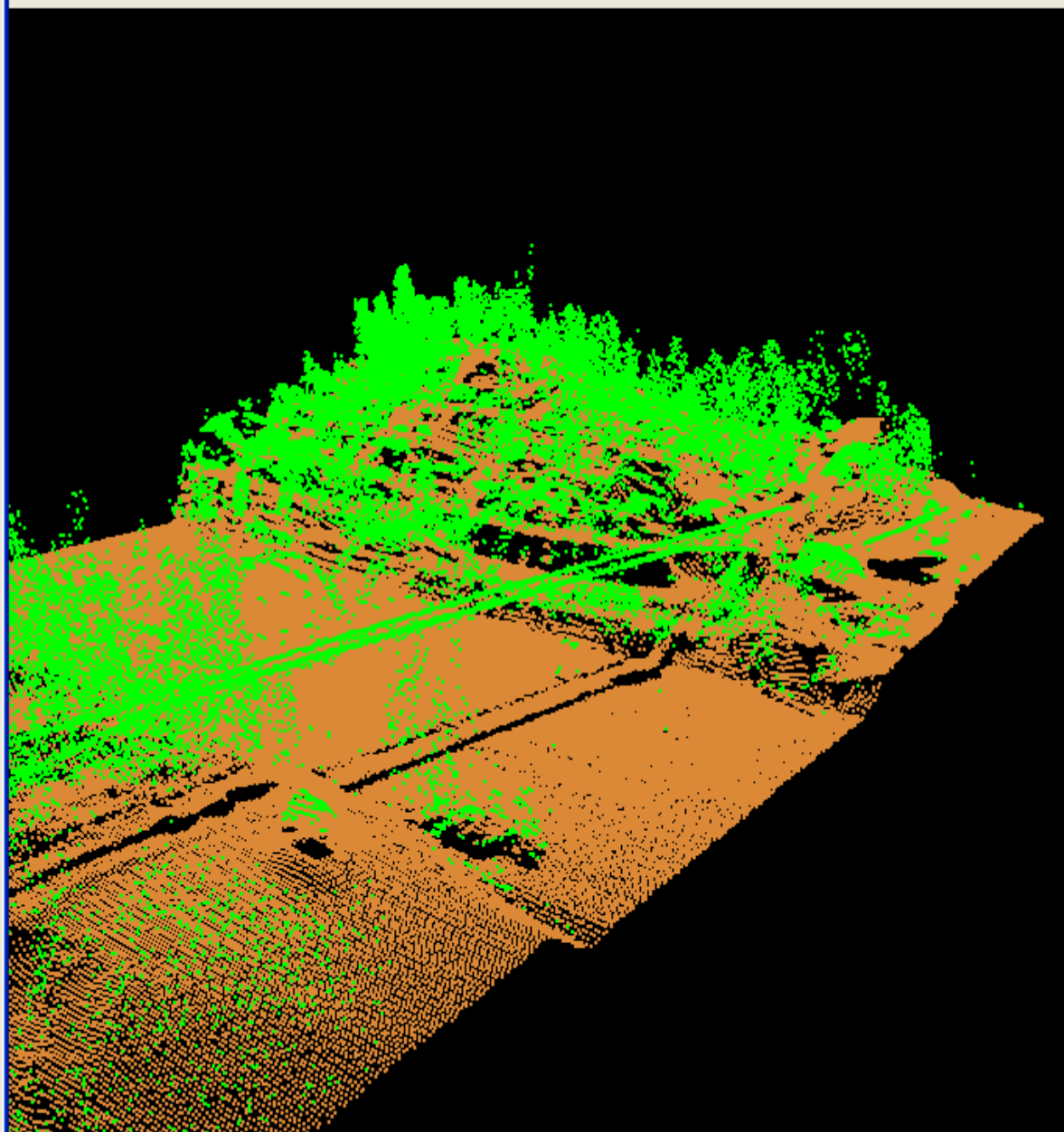


# Classifications Display Settings

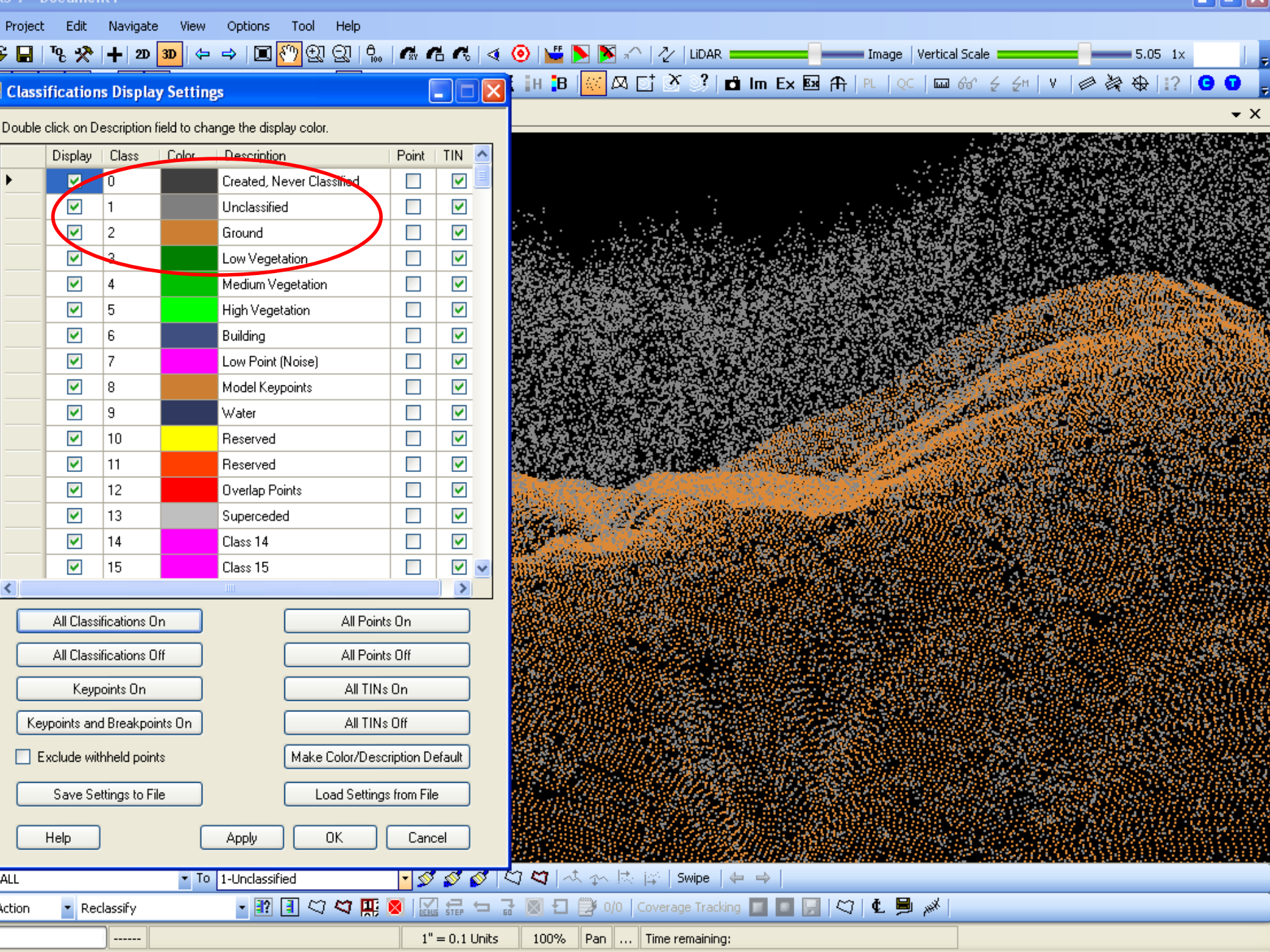
Double click on Description field to change the display color.

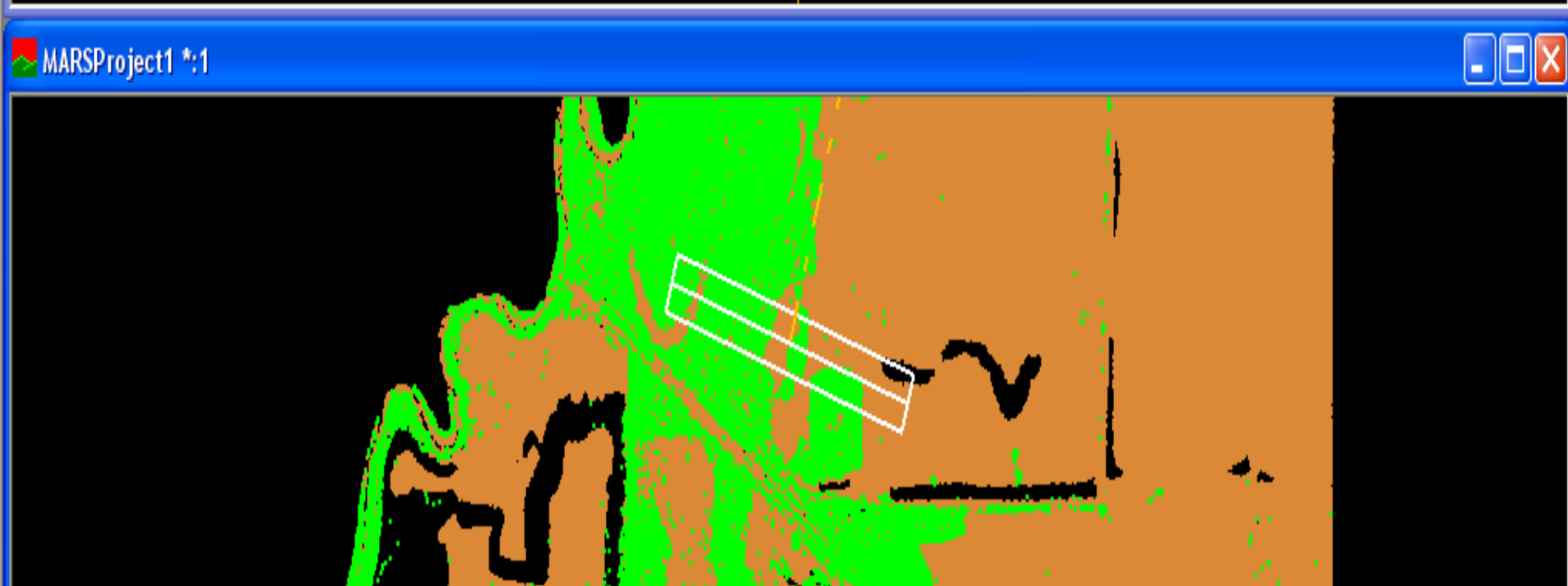
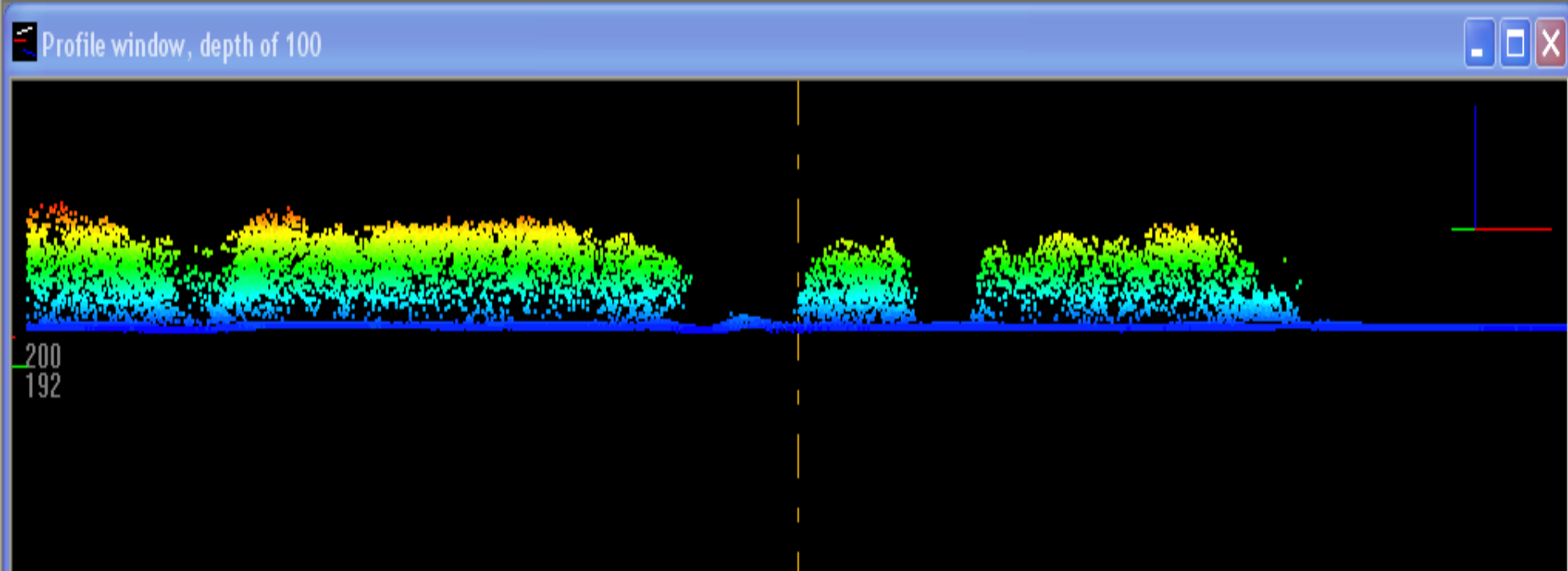
Display	Class	Color	Description	Point	TIN
<input checked="" type="checkbox"/>	0		Created, Never Classified	<input type="checkbox"/>	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>	1		Unclassified	<input type="checkbox"/>	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>	2		Ground	<input type="checkbox"/>	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>	3		Low Vegetation	<input type="checkbox"/>	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>	4		Medium Vegetation	<input type="checkbox"/>	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>	5		High Vegetation	<input type="checkbox"/>	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>	6		Building	<input type="checkbox"/>	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>	7		Low Point (Noise)	<input type="checkbox"/>	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>	8		Model Keypoints	<input type="checkbox"/>	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>	9		Water	<input type="checkbox"/>	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>	10		Reserved	<input type="checkbox"/>	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>	11		Reserved	<input type="checkbox"/>	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>	12		Overlap Points	<input type="checkbox"/>	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>	13		Superceded	<input type="checkbox"/>	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>	14		Class 14	<input type="checkbox"/>	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>	15		Class 15	<input type="checkbox"/>	<input checked="" type="checkbox"/>

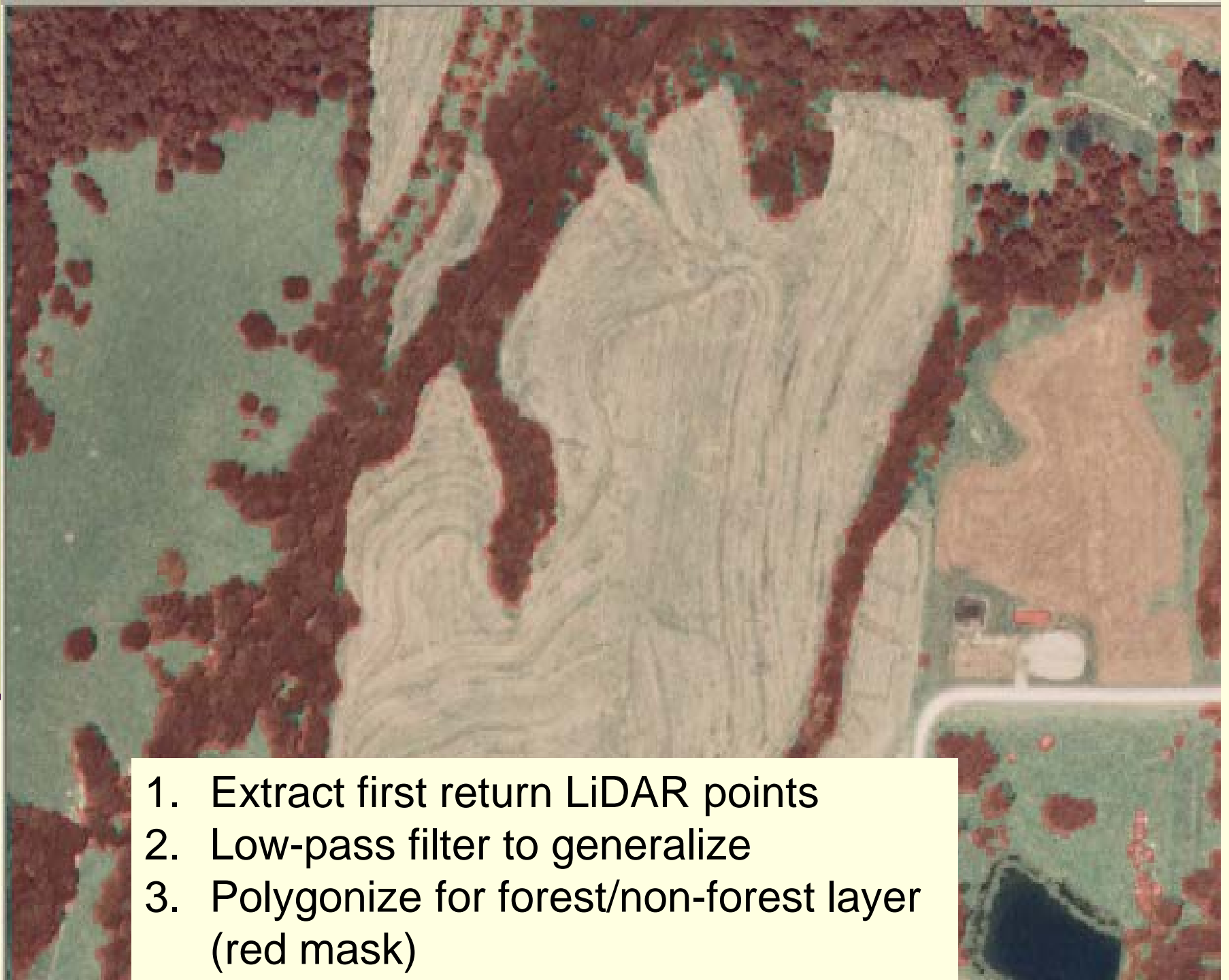
☐ Exclude withheld points







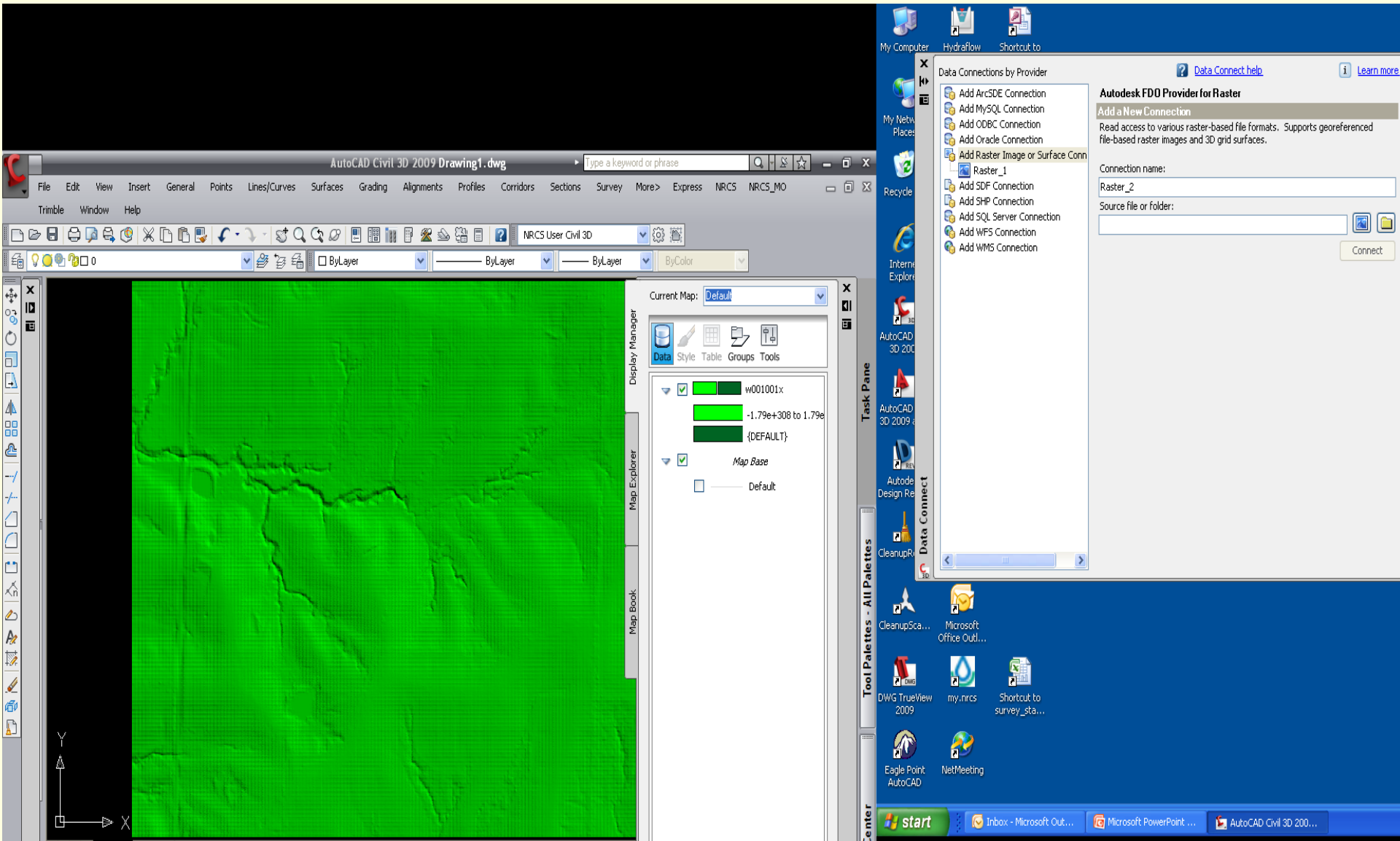


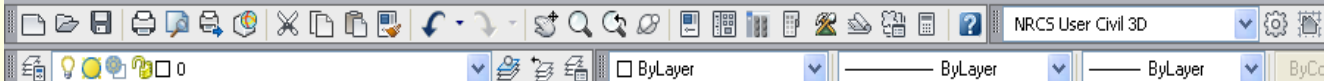


1. Extract first return LiDAR points
2. Low-pass filter to generalize
3. Polygonize for forest/non-forest layer (red mask)



# Data Connect to ESRI Grid in AutoCad

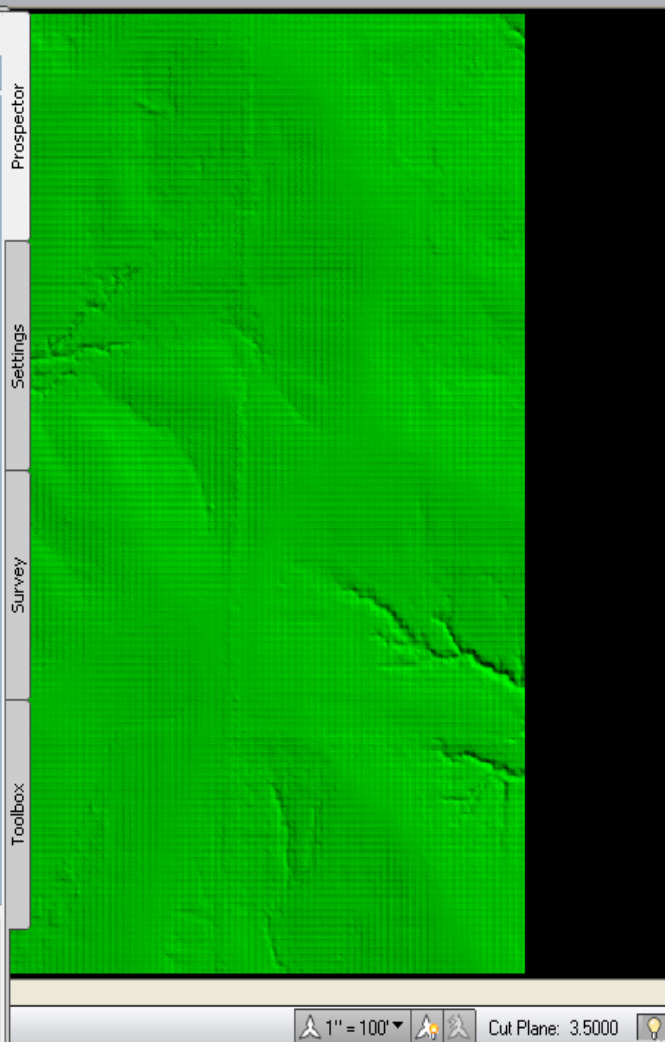




**Master View**

- Open Drawings
  - Drawing1**
    - Points
    - Point Groups
    - Surfaces**
      - Create Surface...
      - Create Surface From DEM...
      - Create Surface from TIN...
      - Show Preview
      - Export to DEM...
      - Export LandXML...
      - Refresh
    - Align
    - Sites
    - Pipe
    - Corri
    - Asse
    - Suba
    - Surv
    - View
  - Data Shortcu
  - Drawing Templates

Name	Description	Style
Ognd	Original Ground	MO Contours



**Task Pane**

**Tool Palettes - All Palettes**

**DesignCenter**

Z=231.73 (Grid from DEM file w001001)

# LiDAR Products for Users

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- Elevation Models (DEMs\* or TINs)
- Relief (Hillshade) Maps \*
- Contour Maps
- Slope Maps
- Aspect Maps
- LAS files for first-return processing\*



# LiDAR Help

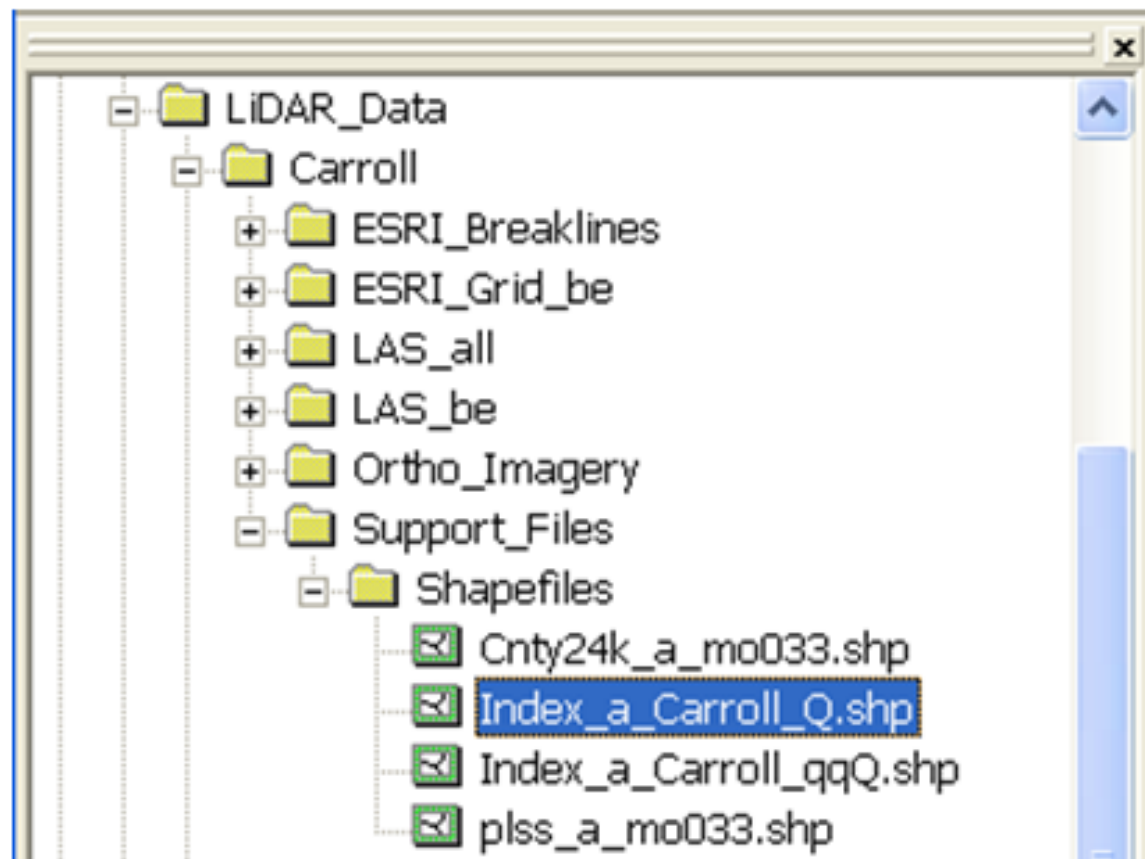


## Technology Technical Note MO-3

**LiDAR USER'S GUIDE  
for ArcMap 9.2**

# LiDAR Index

*Figure 2: ArcMap Index Project Location*



# LiDAR Applications

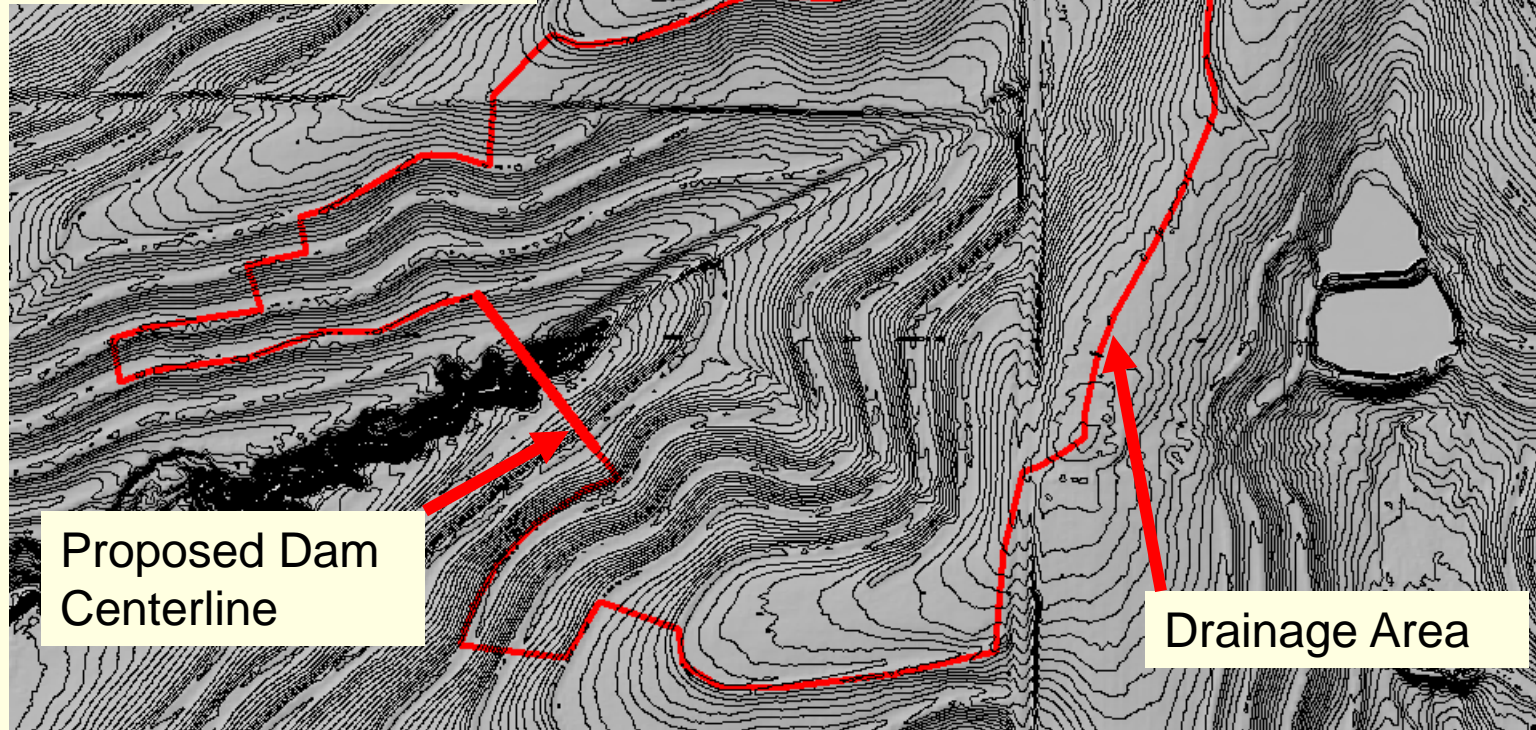
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- Watershed Delineation
- Average Watershed Slope
- RUSLE2 Slopes
- Pipeline Profiles
- Terrace Layout Planning
- Pond and Structure Stage Storage
- Wetland Restoration Planning
- Quantity Estimating
- Floodplain Management Studies

## *Example: Grade Stabilization Dam*

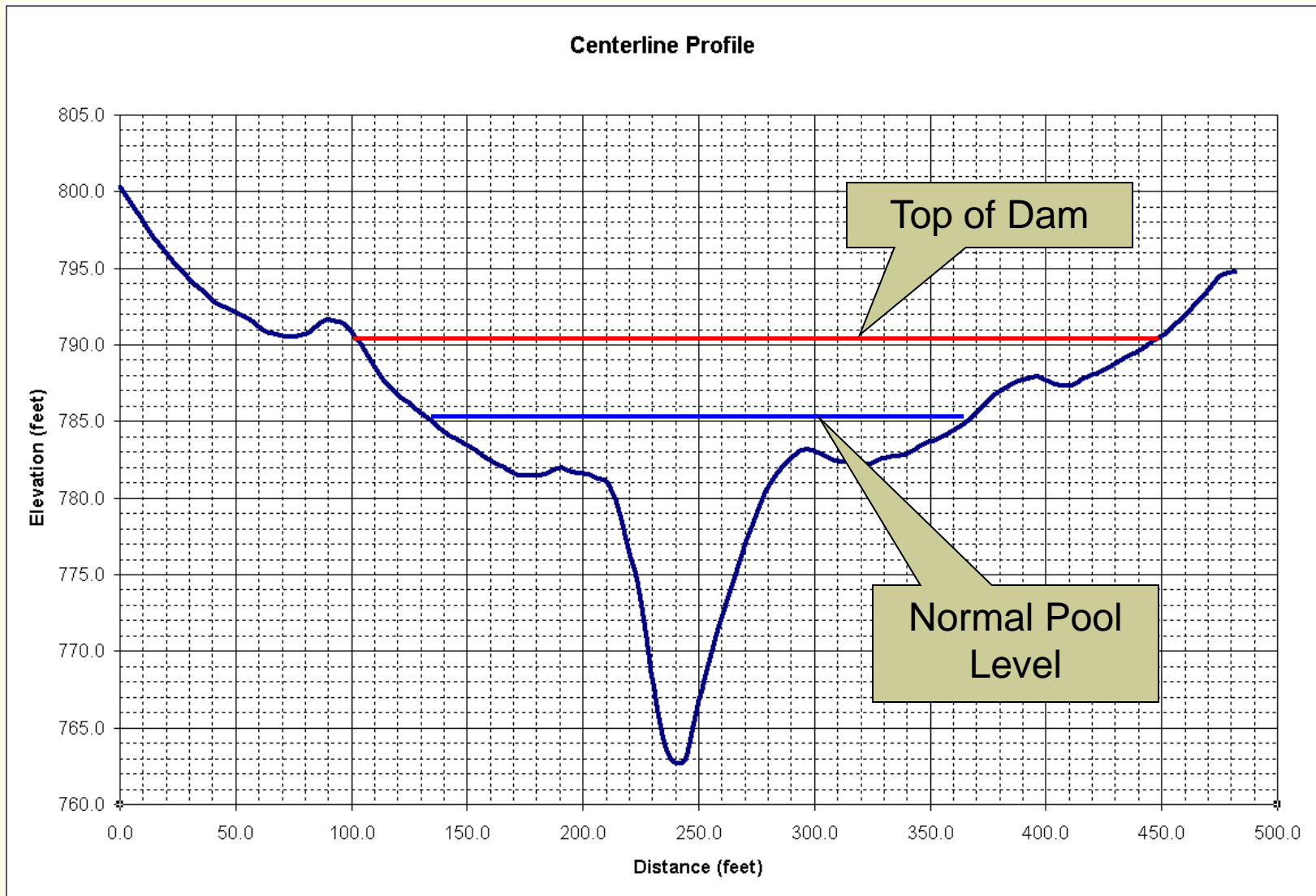
“Hillshade”

Rendering of a  
LiDAR Elevation  
Model with 1 foot  
contours and the  
Drainage Area



















# Example: Grade Stabilization Dam



# LiDAR Applications

Point Spacing (Meter)	Vertical Accuracy (RMSE) (Meter)	Contour Interval (Feet)	Application Supported				
			Base Mapping	Floodplain Mapping	Natural Resources	Civil Planning	Civil Design
1	0.09	1'					 w/ Limits
2	0.20	2'					
3	0.30	3'					
4	0.40	4'					
5	0.51	5'					

Note: This table is for example only. Required accuracy for a specific project must be defined on a case-by-case basis.

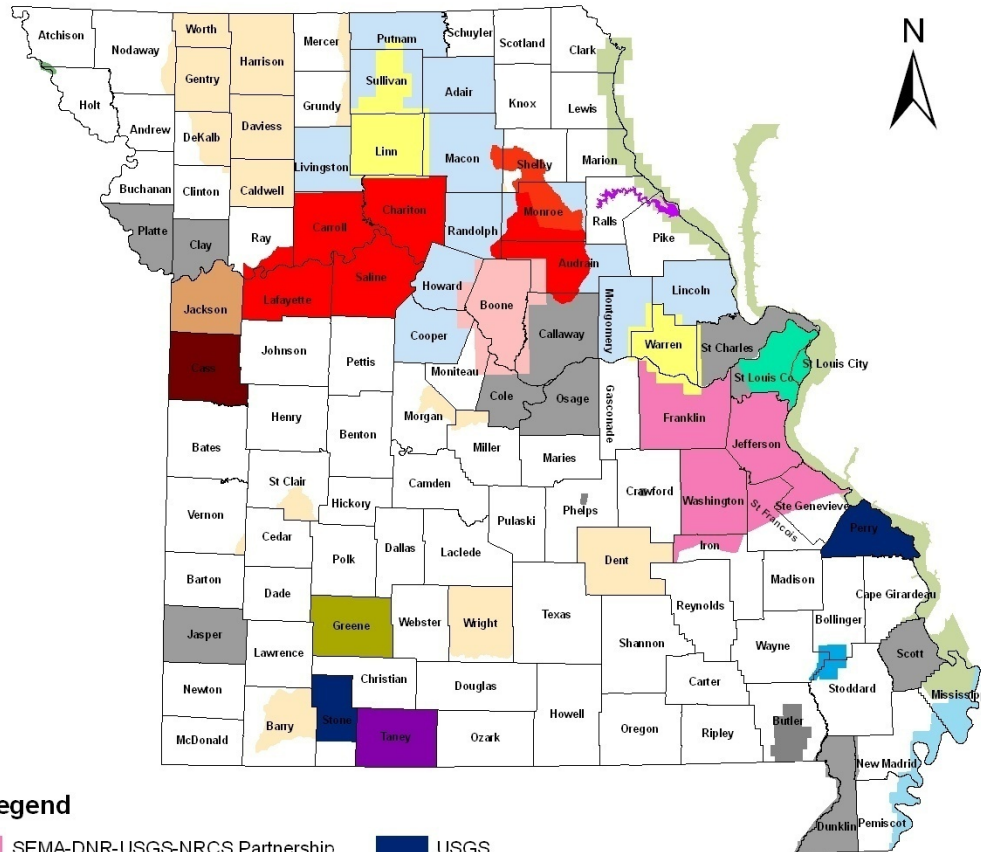
# LiDAR Applications

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## Benefits of a Wide Area Coverage Elevation Model:

- Available on demand.
- Coverage of entire site.
- Coverage of land adjacent to site.
- Can complete planning activities without field surveys.

# Elevation Mapping from Airborne LiDAR Completed or Contracted



## Legend

- |   |   |
|---|---|
| <span style="display:inline-block; width:15px; height:15px; background-color: #FF69B4; border:1px solid black;"></span> SEMA-DNR-USGS-NRCS Partnership        | <span style="display:inline-block; width:15px; height:15px; background-color: #000080; border:1px solid black;"></span> USGS                            |
| <span style="display:inline-block; width:15px; height:15px; background-color: #FFFF00; border:1px solid black;"></span> DNR-NRCS Partnership                  | <span style="display:inline-block; width:15px; height:15px; background-color: #FF0000; border:1px solid black;"></span> NRCS-KC COE Partnership         |
| <span style="display:inline-block; width:15px; height:15px; background-color: #FFB6C1; border:1px solid black;"></span> Boone County                          | <span style="display:inline-block; width:15px; height:15px; background-color: #3CB371; border:1px solid black;"></span> KC COE                          |
| <span style="display:inline-block; width:15px; height:15px; background-color: #8A2BE2; border:1px solid black;"></span> St. Louis COE                         | <span style="display:inline-block; width:15px; height:15px; background-color: #90EE90; border:1px solid black;"></span> Rock Island COE                 |
| <span style="display:inline-block; width:15px; height:15px; background-color: #8B8723; border:1px solid black;"></span> Greene County                         | <span style="display:inline-block; width:15px; height:15px; background-color: #6495ED; border:1px solid black;"></span> Memphis COE                     |
| <span style="display:inline-block; width:15px; height:15px; background-color: #8B0000; border:1px solid black;"></span> Cass County                           | <span style="display:inline-block; width:15px; height:15px; background-color: #FFDAB9; border:1px solid black;"></span> SEMA (RISKMap 4ft Contour Spec) |
| <span style="display:inline-block; width:15px; height:15px; background-color: #ADD8E6; border:1px solid black;"></span> NRCS-SEMA-USGS-KC COE Partnership     |   |
| <span style="display:inline-block; width:15px; height:15px; background-color: #D2B48C; border:1px solid black;"></span> Jackson County                        |   |
| <span style="display:inline-block; width:15px; height:15px; background-color: #800080; border:1px solid black;"></span> Taney County                          |   |
| <span style="display:inline-block; width:15px; height:15px; background-color: #00CED1; border:1px solid black;"></span> Metropolitan St. Louis Sewer District |   |
| <span style="display:inline-block; width:15px; height:15px; background-color: #A9A9A9; border:1px solid black;"></span> SEMA                                  |   |
| <span style="display:inline-block; width:15px; height:15px; background-color: #00BFFF; border:1px solid black;"></span> MDC                                   |   |

Note: Collection specifications vary some among projects. However, all data except those noted as RiskMap 4ft spec were collected to support at least a 2ft contour mapping standard.



# Helping People Help the Land

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