Creating LiDAR Products –

Evaluating Processing Methods \Techniques

City of Springfield GIS

Nathan Huggins

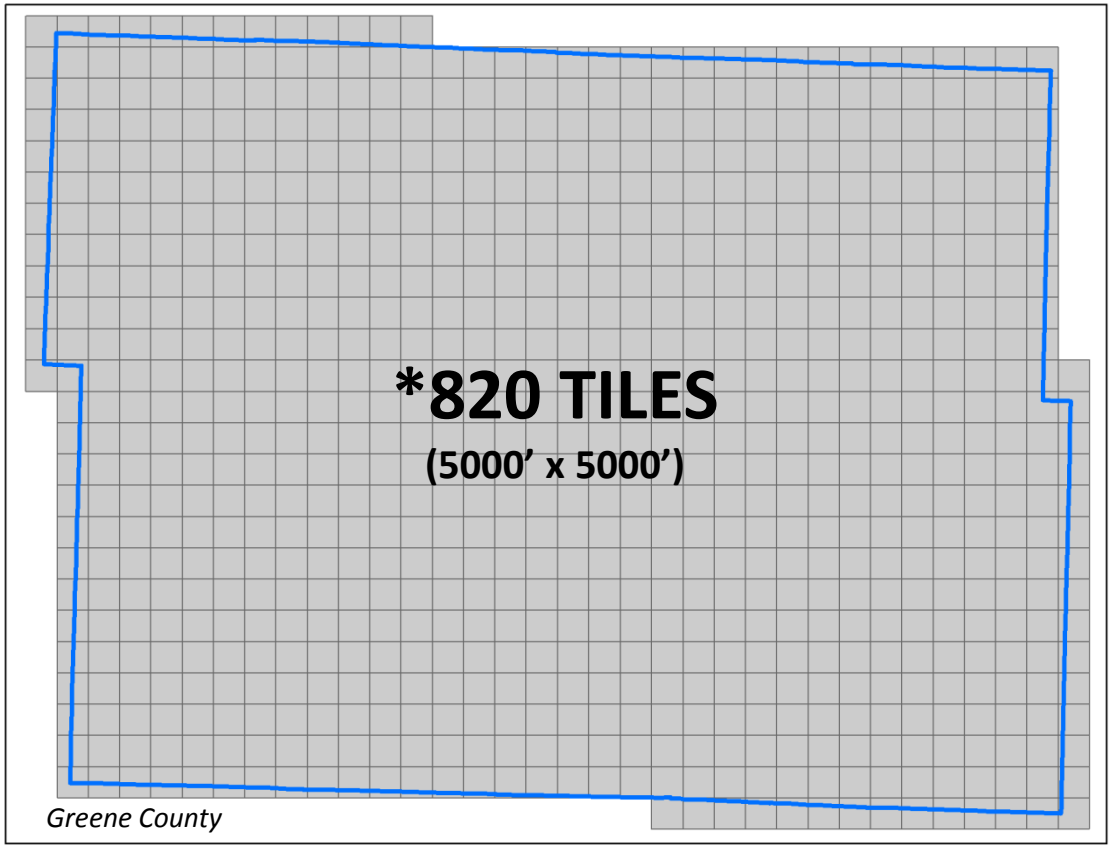
Advanced LiDAR Workshop
March 15, 2012

LiDAR Project Details

- Background
  - Partnership of several organizations
    - Greene County
    - USGS
    - US Army Corps of Engineers
  - Covered Greene County ~ over 678 square miles
  - Flight took place in late January 2011
  - Ground sampling distance 0.7 meters
  - Vertical bare earth accuracy – 15 cm (5.9 in) RMSE
  - 4 classes
  - $300,000+ cost

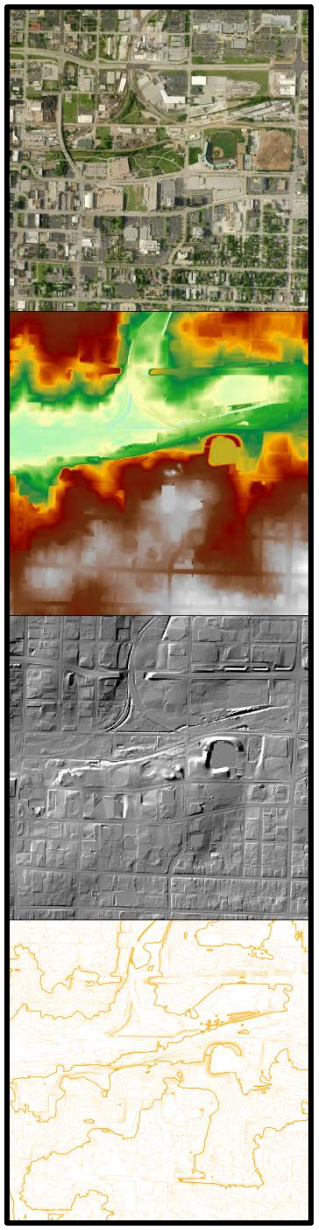
LiDAR Delivery (700+ gb)

- Hard Drive - May 2011
  - ASCII BE (.txt)
  - Bare Earth (.las)
  - Classified (.las)
  - DTM (.shp)
    - X, Y, Z, Class, RetNum
  - ESRI DEMs (grid)
    - ½ meter – 1.64 ft
  - Raw LiDAR (.las)
  - Tile Schema (.shp)



LiDAR Products "Wanted"

- LiDAR Products Requested
  - Raster Products
    - County-wide DEM
      - Transition from 30m → ½m DEM
      - Spot Elevations
    - Hillshade
    - Digital Surface Model
  - Vector Products
    - Contours
      - 5' Cartographic
      - 1' Engineering – Preliminary Design
      - Scale dependent layer file
      - Possibly cached in ArcServer
  - Data Layers → Standard Project(s)



Resources

Hardware

- Virtual Server
  - Windows Server 2008 R2 Standard
  - 64-bit
  - 10 gb RAM
  - 275 gb Disk Space – (2 drives)
    - Requested 1tb
    - Delivery data on separate server
    - No recovery solution

Software

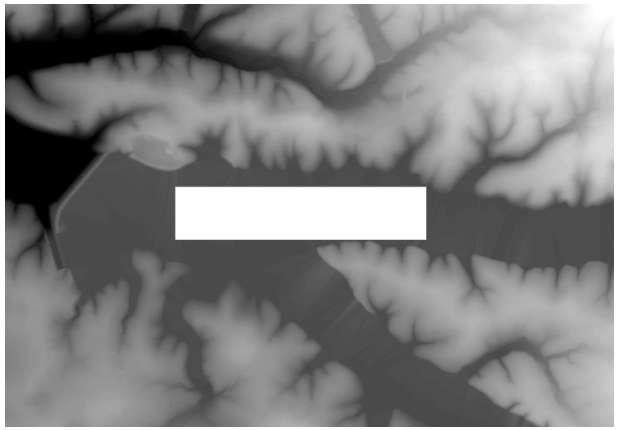
- ESRI – v10
  - ArcInfo License
  - Extensions
    - Spatial Analyst
    - 3D Analyst
  - Community Base Map
    - ContourHarvester
    - ElevationLine
  - Model Builder \ Python

DEM Creation & QC

- Delivery 820 ESRI Grids – 1.64 ft pixel, 35.8 mb each
- Imported DEMs into a File Geodatabase
- Produced 2 Mosaics
  - "Mosaic Dataset" within new FGDB - new in v10
    - Create quickly and used for QC and contour creation
      - 3 min 42 seconds
    - Only contain references to source data
    - On the fly processing through functions
  - Raster Dataset – Columns and Rows (103,664 : 79,273)
    - Single file – 20 gb
    - 12+ hours processing

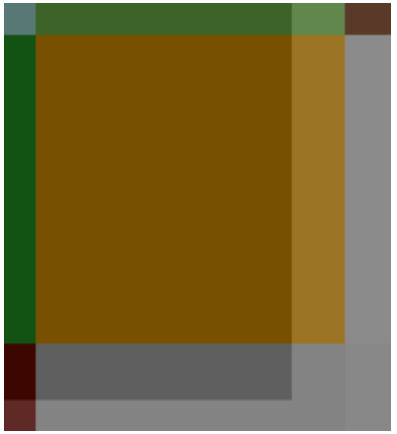
DEM Creation & QC cont'd

- City QC Process
  - Checked 500 overlapping pixels
  - Identified large data void
- Received USGS "Elevation QA Report"
  - Fixed 13 bridge removal errors
  - Fixed building removal artifact
  - Filled in data void



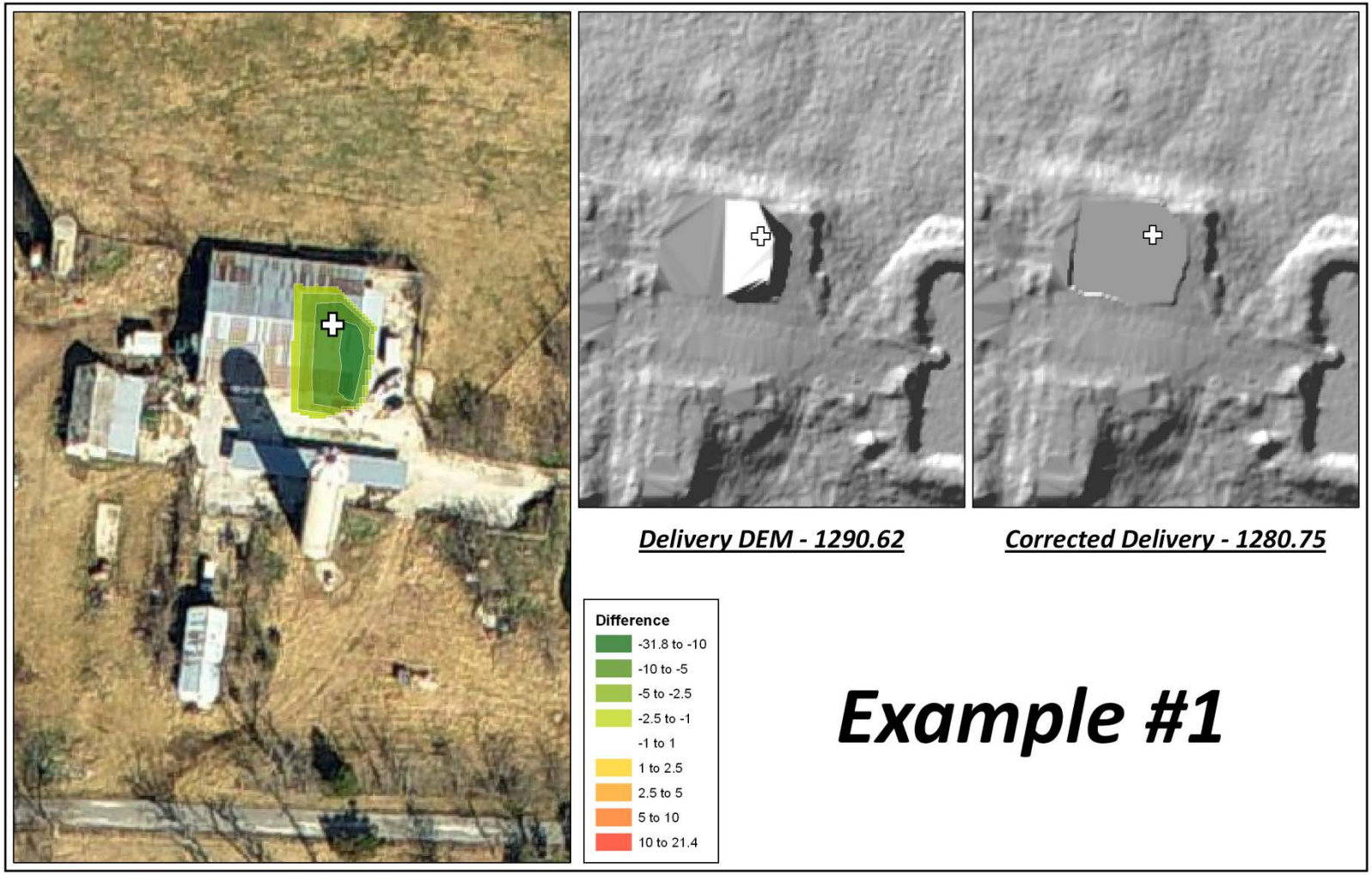
- Requested and received copy of "Corrected" DEMs from USGS
  - SPCS projection but elevation was in meters
  - 20 .img files
- Determine the "Difference" → Delivered vs. Corrected

DEM Comparison



- Import Corrected .img files into FGDB
  - Snap Raster to Delivery Mosaic ~ .4ft
- Created Raster Dataset for Corrected
  - Converted from meters to feet
  - Set Null for values = -9999
- Created “Difference” Mosaic Dataset
  - Used Arithmetic function to subtract 2 raster datasets
  - Exported and Reclassified to create statistics
  - Created Difference example maps
- Decided to use Corrected DEM
  - 98% of pixels were within ± .10 ft in elevation between the Corrected DEM & the Delivery DEM

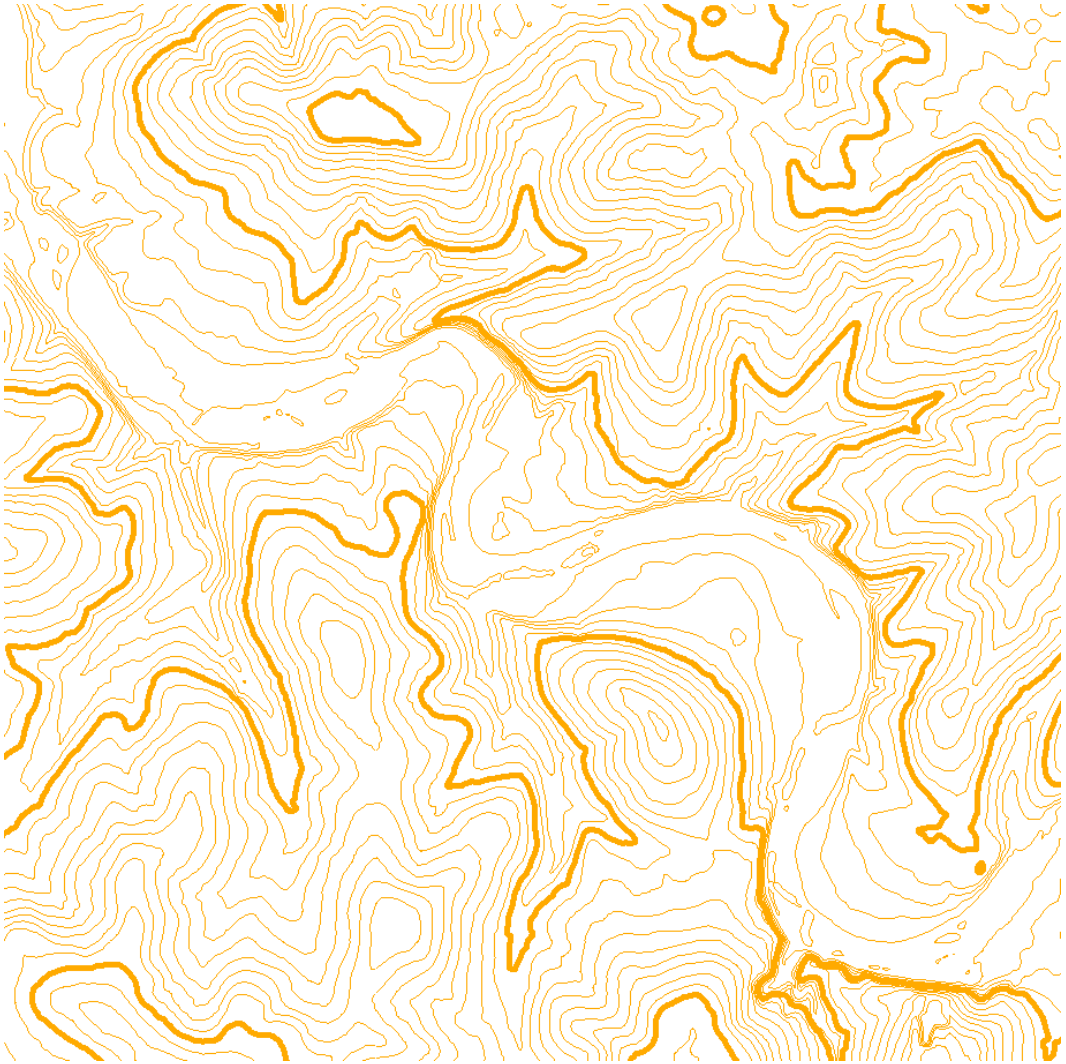
Corrected vs. Delivered Map Example

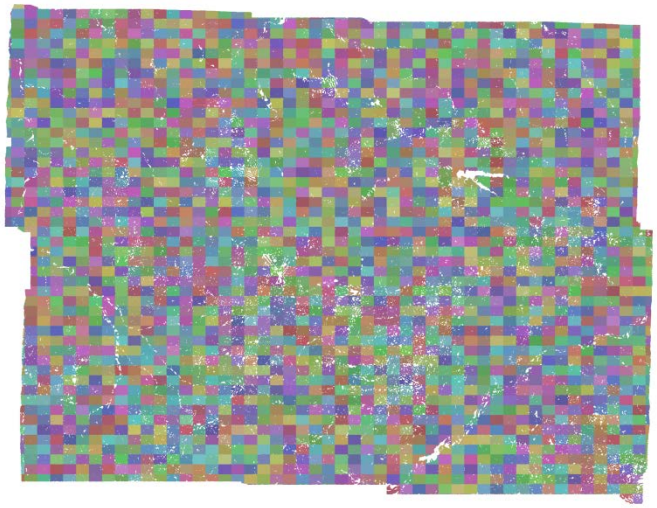


Contour Processing

- Created 5 ft cartographic contours
  - Originally to be used only within Community Base Maps
  - Walkthrough by ESRI staff – Arthur Crawford (St. Charles)
  - Used Delivery Mosaic Dataset initially created
    - Series of 3 “Statistics” functions: i.e. Smoothing
      - 20 x 20 neighborhood – calculates the mean
  - Community Base Map Tools – Contour Harvester
    - Alter script based on pixel cell size
  - Simplify Line = .50 ft
  - Community Base Map Tools – Elevation Line Index Tool
    - Indexes @ 10, 25, 50, 100, 250

5ft Cartographic Contours & Issue





2382 Grids

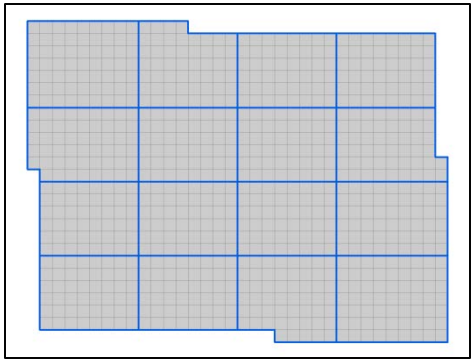
Error After Simplify - 1:100

1ft Contours → Trial & Error(s)

- 1ft “Engineering” contours – accurate
  - Use non-smoothed DEM
- Multiple attempts and strategies for creating 1ft
- Initial idea create contours for entire county
  - Use the Delivered Mosaic Dataset and Spatial Analyst
  - Ran 15+ hours then failed
    - 999999 : Error executing function
  - Re-booted the server, increased virtual memory & tried again – same result
  - Determined just not enough memory \ processing
  - Flawed idea → drawing performance issues

1ft Contours cont'd

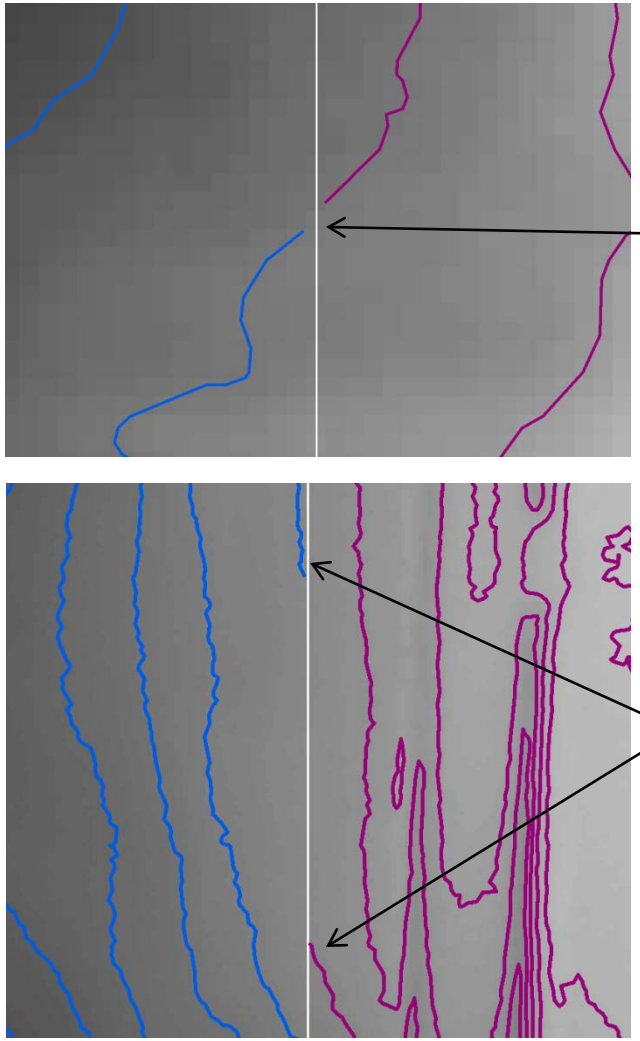
- New strategy: Process smaller areas → Append
  - Toolbox: Environment Settings: Processing Extent
- Using tile layout created 16 processing grid polygons
  - Success – 1ft contours created
  - Run Simplify = .25ft (greatly reduces file size)
    - Vertex every pixel = poor draw performance
  - Removed contours less than 50 ft in length
    - Aesthetically more pleasing, less "noise"
    - Less features better performance
  - Imported into Feature Dataset with .01ft XY tolerance
  - Appended 16 parts into single feature class
    - Elevation Line Index Tool: Indexes @ 2, 5, 10, 20, 50



Contour Process Example / QC

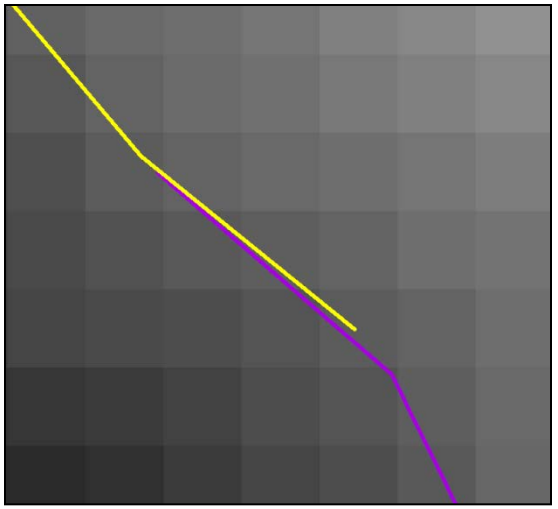
Grid 1 Contours

- Initially – 1.09 gb
- Simplify – 194 mb
  - .25ft
- Delete – 172 mb
  - Contours < 50ft
  - Features 184,521 → 21,947
- Import FD – 96 mb
  - XY tolerance = .01
- All: 22.7 gb → 1.8 gb



Contours → Try Again

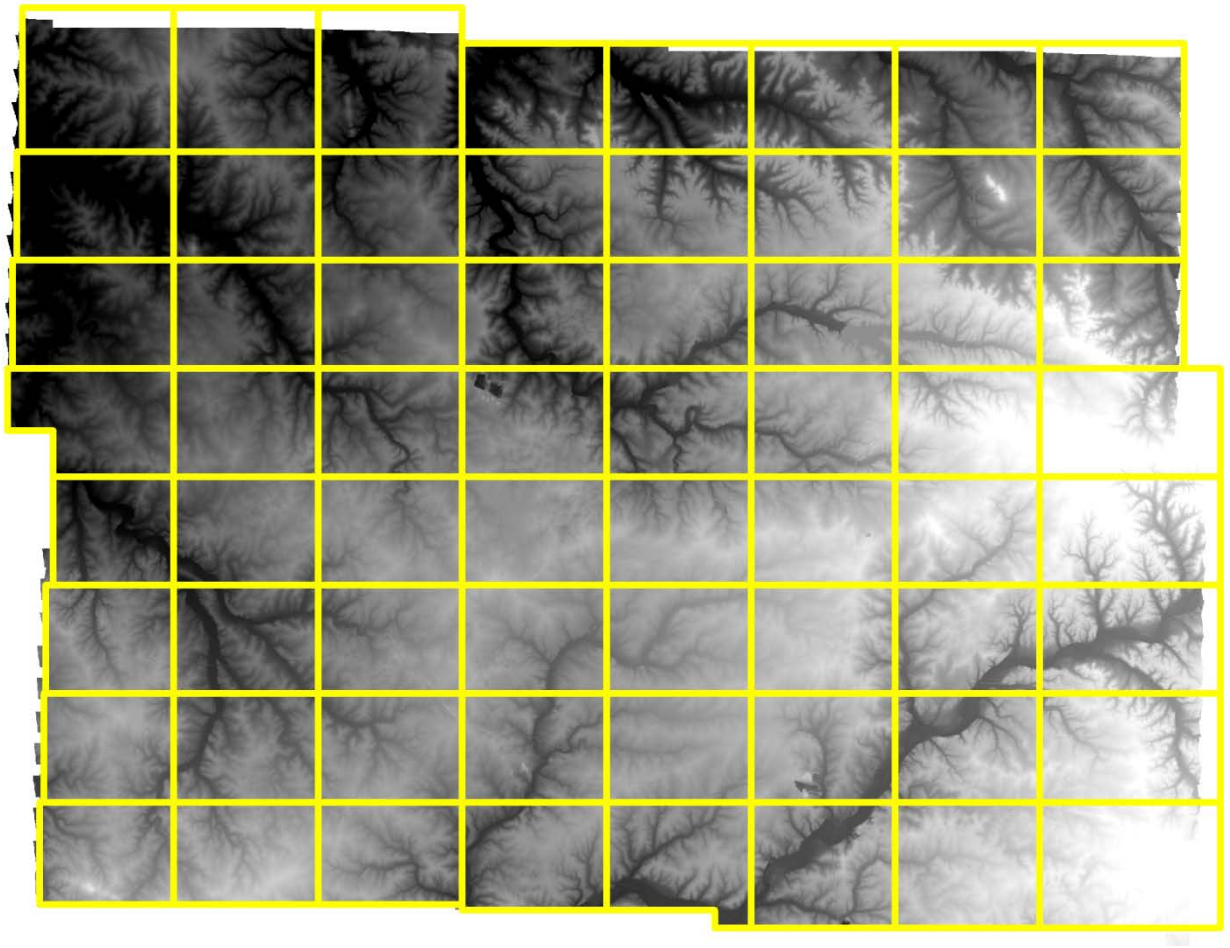
- Contours unacceptable – missing segments
  - Processing grid
  - Deleting contours < 50
- Back to Contour Harvester
  - Created 1ft contours
  - Overlap \ Intersect errors
  - Attempt to use topology rules to fix
  - 2382 Grids = 10,000+?? errors
  - Determine no easy/quick solution
  - Abandon hope

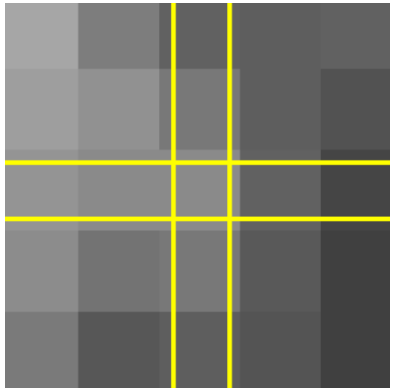


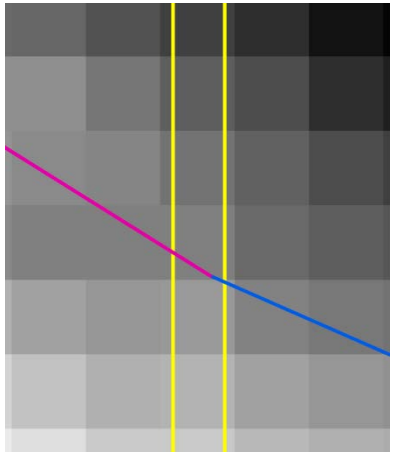
Contours → New Processing Grid

- Re-Evaluate processing grid
  - Contours from adjoining processing grids should touch
  - Used a small test area and tested different parameters
  - Determined grids that overlapped within the same pixel produced coincident contour endpoints
  - Created 64 new processing grid polygons
    - Expanded from 16 to increase draw time (Contour Harvester)
    - 64 largest manageable number: split old 16 into quarters
    - Started ¼ inch and ¼ up from the corner of a pixel
    - Determined width and height length in pixels of interior grids
    - Manually set X,Y's of all polygon corners to ensure proper overlap
    - No data values also affect results – left side and bottom

Contours 64 Poly Processing Grid



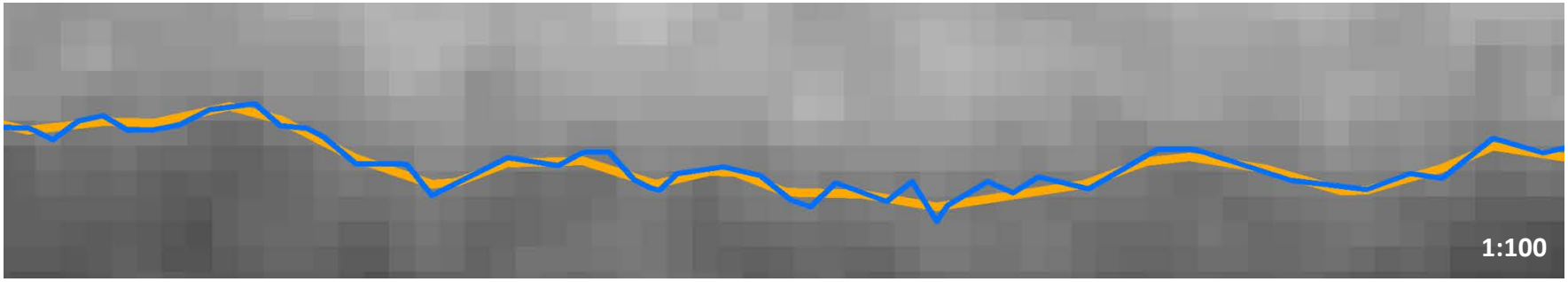


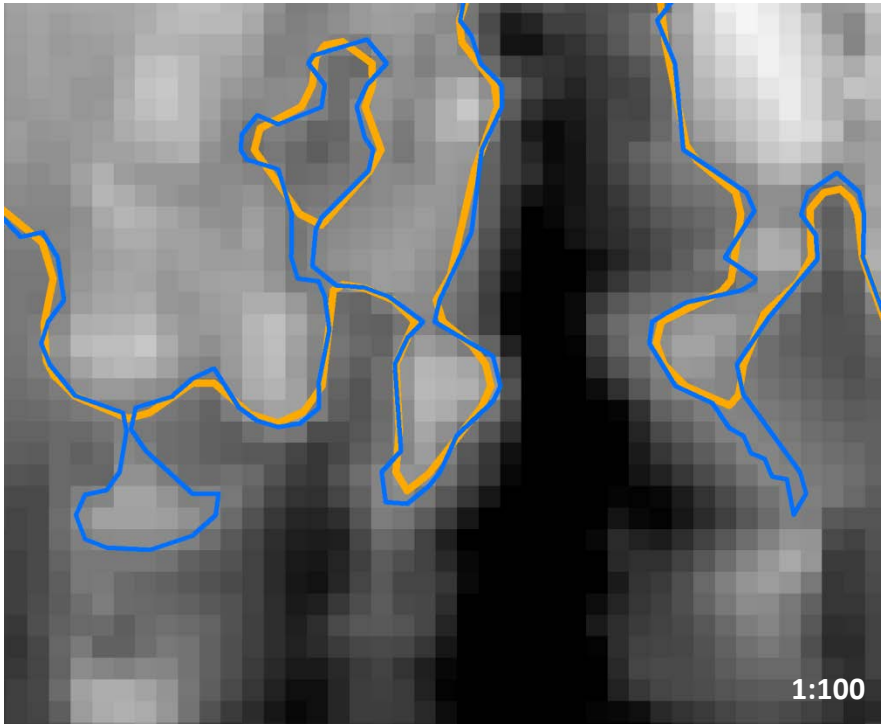


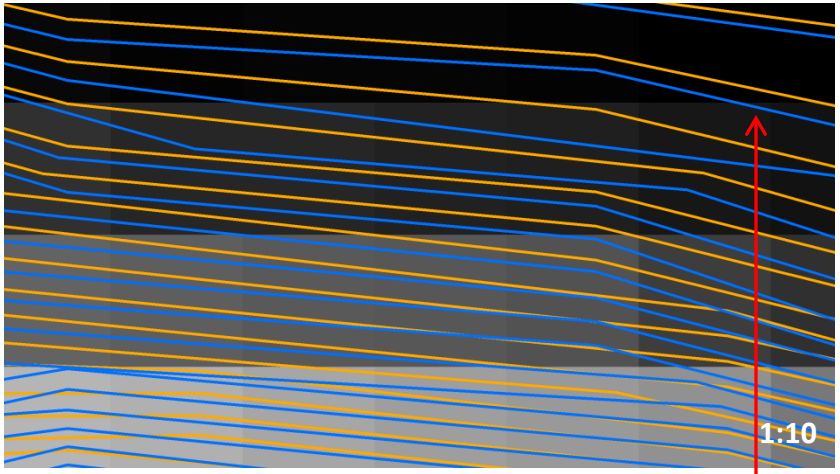
Final Contours Created

- Used new 64 grid and Corrected Mosaic Dataset
  - Evaluated smoothing techniques – ESRI & ET GeoWizard
  - Smoothed it by 3 x 3 pixel window
  - Good balance between accuracy and aesthetics
- Created 64 contours files
  - Simplify = .25ft
  - Created python script – ran in batch mode
    - Removed contours less than 31ft except ones that intersected tile boundaries
  - Appended 64 parts into single feature class (1.24 gb) in FD
    - Elevation Line Index Tool: Indexes @ 2, 5, 10, 20, 50

Contour Examples

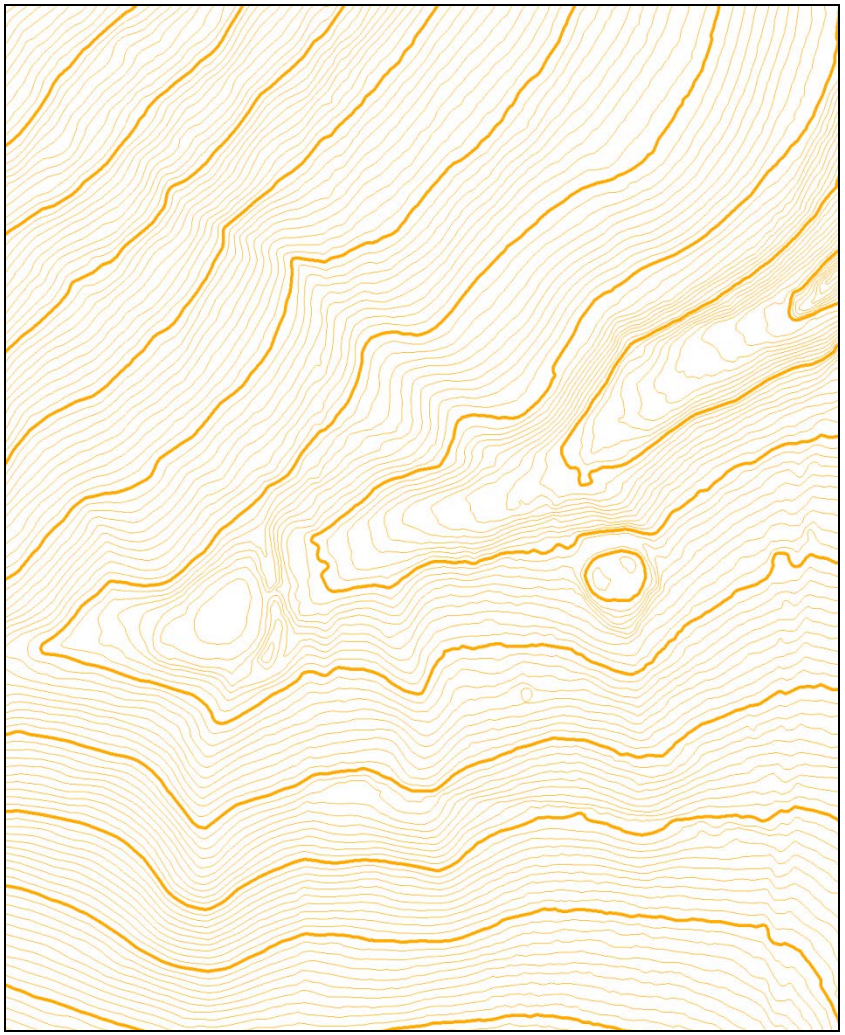


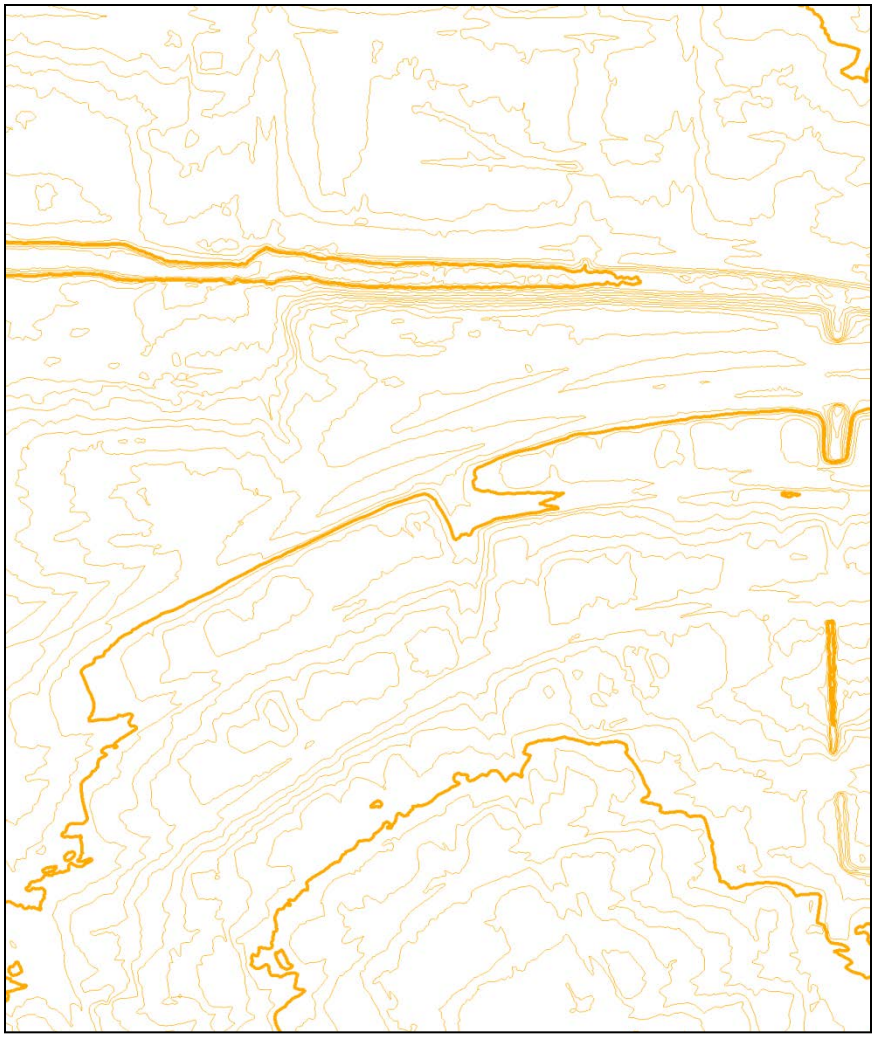




Bluff line
½ ft difference
Regular vs.
Smoothed

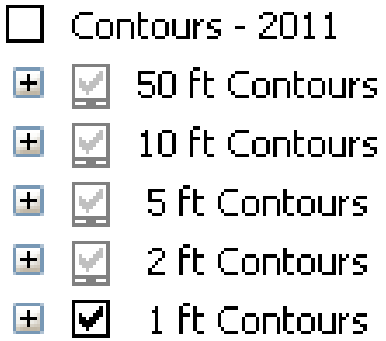
Contour Examples cont'd





Final Steps and Future Plans

- Loaded DEM & Contours into SDE
- Created a scale dependent contour layer file
  - Includes 5ft and 1ft contours
- Distribute LiDAR and Products
  - MSDIS LiDAR ftp
  - Local Government Data ftp
- Educate users
  - City employees & engineering community
  - Create video on using .las files in AutoCAD



Thank You – Questions??