



# LiDAR Quality Assessment Report

The USGS National Geospatial Technical Operations Center, Data Operations Branch is responsible for conducting reviews of all Light Detection and Ranging (LiDAR) point-cloud data and derived products delivered by a data supplier before it is approved for inclusion in the National Elevation Dataset and the Center for LiDAR Information Coordination and Knowledge. The USGS recognizes the complexity of LiDAR collection and processing performed by the data suppliers and has developed this Quality Assessment (QA) procedure to accommodate USGS collection and processing specifications with flexibility. The goal of this process is to assure LiDAR data are of sufficient quality for database population and scientific analysis. Concerns regarding the assessment of these data should be directed to the Chief, Data Operations Branch, 1400 Independence Road, Rolla, Missouri 65401 or NGTOCooperations@usgs.gov.

Materials Received:

3/14/2013

Project ID:

MO\_Monroe-Audrain-MontgomeryCos\_2011

Project Alias(es):

MO\_Grand\_2011

Project Type: Donated Data

Project Description:

Monroe, Audrain, and Montgomery Counties are part of the Missouri Grand 2011 LiDAR dataset. The St. Louis District of the United States Army Corps of Engineers (USACE) contracted with Surdex Corporation in the fall of 2011 to collect high resolution LiDAR elevation data over multiple counties as part of the Missouri Grand Counties Lidar Project. This project consists of 4 delivery blocks including all or part of Howard, Cooper, Montgomery, Livingston, Randolph, Monroe, Audrain, Lincoln, Macon, Adair, Sullivan, Putnam, and St. Louis City and County. There is additional coverage within Ray, Gasconade, St. Francois and Jackson Counties. The project combines the varied interests of the NRCS, USGS, USACE and State Emergency Management Agency (SEMA) totaling over 6287 square miles into a unified collection and processing project to benefit the US Government. The NRCS shall serve as the technical point of contact with the USACE St Louis District.

Year of Collection: 2011

Lot 1 of 1 lots.

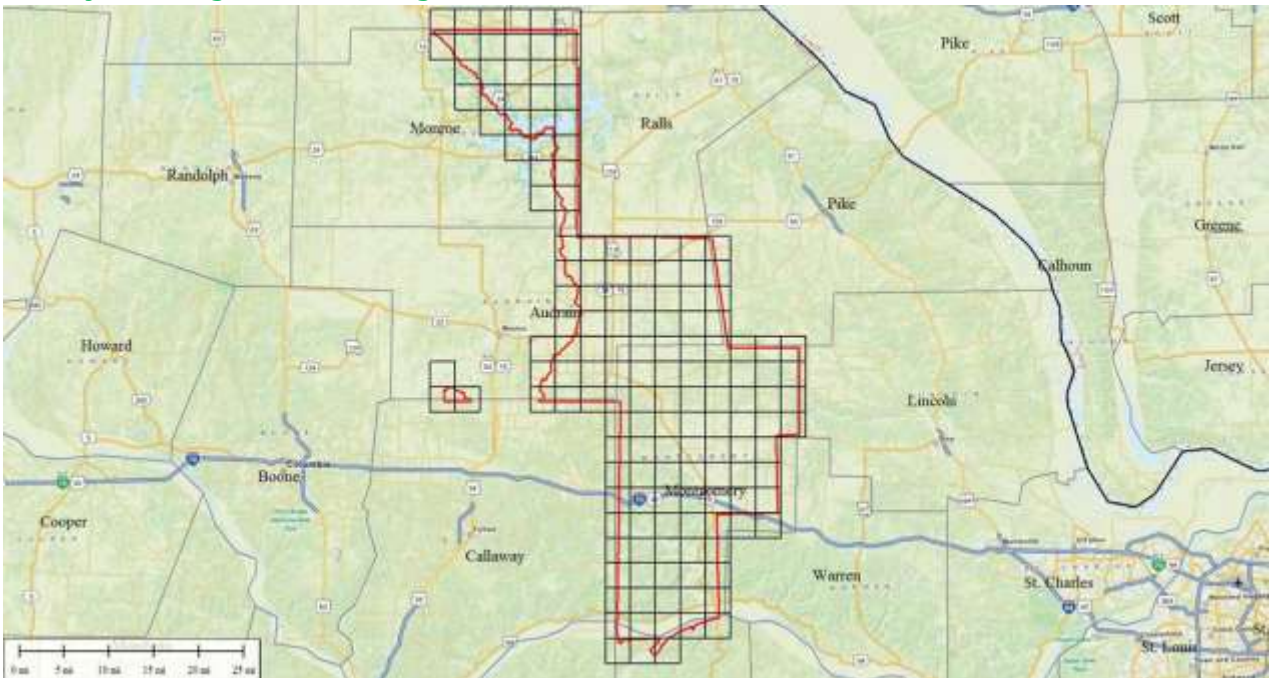
Project Extent:

Project Extent image?



Project Tiling Scheme:

Project Tiling Scheme image?



Contractor:

Surdex

Applicable Specification:

V13

Licensing Restrictions:

Third Party Performed QA?

Project Points of Contact:

POC Name	Type	Primary Phone	E-Mail
Ray Fox	NSDI Liaison	573-308-3744	rfox@usgs.gov

# Project Deliverables

All project deliverables must be supplied according to collection and processing specifications. The USGS will postpone the QA process when any of the required deliverables are missing. When deliverables are missing, the Contracting Officer Technical Representative (COTR) will be contacted by the Elevation/Orthoimagery Section supervisor and informed of the problem. Processing will resume after the COTR has coordinated the deposition of remaining deliverables.

- Collection Report
- Survey Report
- Processing Report
- QA/QC Report
- Control and Calibration Points
- Project Shapefile/Geodatabase
- Control Point Shapefile/Gdb
- Project Tiling Scheme Shapefile/Gdb
- Breakline Shapefile/Gdb
- Project XML Metadata
- Swath LAS XML Metadata
- Classified LAS XML Metadata
- Breakline XML Metadata
- Bare-Earth DEM XML Metadata

## Multi-File Deliverables

File Type	Quantity
<input checked="" type="checkbox"/> Swath LAS Files	129
<input type="checkbox"/> Intensity Image Files	1
<input checked="" type="checkbox"/> Tiled LAS Files	157
<input checked="" type="checkbox"/> Breakline Files	162
<input type="checkbox"/> Bare-Earth DEM Files	157

## Additional Deliverables

Errors, Anomalies, Other Issues to document?  Yes  No

None.

# Project Geographic Information

Areal Extent:

905.8

Sq Mi

Grid Size:  
  
meters

Tile Size:  
  
meters

Nominal Pulse Spacing:  
  
meters

Vertical Datum:  meters

Horizontal Datum:  meters

Project Projection/Coordinate Reference System:  meters.

This Projection Coordinate Reference System is consistent across the following deliverables:

- |   |  |
|---|--|
| <input checked="" type="checkbox"/> Project Shapefile/Geodatabase       | <input checked="" type="checkbox"/> Breaklines XML Metadata File     |
| <input checked="" type="checkbox"/> Project Tiling Scheme Shapefile/Gdb | <input checked="" type="checkbox"/> Bare-Earth DEM XML Metadata File |
| <input checked="" type="checkbox"/> Checkpoints Shapefile/Geodatabase   | <input type="checkbox"/> Swath LAS Files                             |
| <input checked="" type="checkbox"/> Project XML Metadata File           | <input checked="" type="checkbox"/> Classified LAS Files             |
| <input checked="" type="checkbox"/> Swath LAS XML Metadata File         | <input checked="" type="checkbox"/> Breaklines Files                 |
| <input checked="" type="checkbox"/> Classified LAS XML Metadata File    | <input checked="" type="checkbox"/> Bare-Earth DEM Files             |

# Review Cycle

This section documents who performed the QA Review on a project as well as when QA reviews were started, actions passed, received, and completed.

Reviewer:

T. Jerris

Review Start Date:

3/26/2013

Action to Contractor Date	Issue Description	Return Date
4/26/2013	Summary of Errors: <ul style="list-style-type: none"><li>- 2 @ bridges not removed from DEM</li><li>- 104 @ roadways removed over culverts</li><li>- 2 @ areas with linear anomalies</li><li>- 1 @ Swath LAS file missing</li><li>- Swath LAS having "No Coordinate System"</li></ul>	5/22/2013

Review Complete: 6/10/2013

## Metadata Review

Provided metadata files have been parsed using 'mp' metadata parser. Any errors generated by the parser are documented below for reference and/or corrective action.

The Project XML Metadata file parsed without errors.

The Swath LAS XML Metadata file parsed without errors.

The Classified LAS XML Metadata file parsed without errors.

The Breakline XML Metadata file parsed without errors.

The Bare-Earth DEM XML Metadata file parsed without errors.

# Project QA/QC Report Review

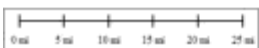
ASPRS recommends that checkpoint surveys be used to verify the vertical accuracy of LiDAR data sets. Checkpoints are to be collected by an independent survey firm licensed in the particular state(s) where the project is located. While subjective, checkpoints should be well distributed throughout the dataset. National Standards for Spatial Data Accuracy (NSSDA) guidance states that checkpoints may be distributed more densely in the vicinity of important features and more sparsely in areas that are of little or no interest. Checkpoints should be distributed so that points are spaced at intervals of at least ten percent of the diagonal distance across the dataset and at least twenty percent of the points are located in each quadrant of the dataset.

NSSDA and ASPRS require that a minimum of twenty checkpoints (thirty is preferred) are collected for each major land cover category represented in the LiDAR data. Checkpoints should be selected on flat terrain, or on uniformly sloping terrain in all directions from each checkpoint. They should not be selected near severe breaks in slope, such as bridge abutments, edges of roads, or near river bluffs. Checkpoints are an important component of the USGS QA process. There is the presumption that the checkpoint surveys are error free and the discrepancies are attributable to the LiDAR dataset supplied.

For this dataset, USGS checked the spatial distribution of checkpoints with an emphasis on the bare-earth (open terrain) points; the number of points per class; the methodology used to collect these points; and the relationship between the data supplier and checkpoint collector. When independent control data are available, USGS has incorporated this into the analysis.

## Checkpoint Shapefile or Geodatabase:

- Checkpoint Distribution Image?





The following land cover classes are represented in this dataset (uncheck any that do not apply):

- Bare Earth
- Tall Weeds and Crops
- Brush Lands and Low Trees
- Forested Areas Fully Covered by Trees
- Urban Areas with Dense Man-Made Structures

There are a minimum of 20 checkpoints for each land cover class represented. Points within each class are uniformly distributed throughout the dataset. USGS was able to locate independent checkpoints for this analysis. USGS accepts the quality of the checkpoint data for these LiDAR datasets.

Errors, Anomalies, Other Issues to document?  Yes  No

Image?

This dataset is a redelivery of the Monroe, Audrain, and Montgomery Counties, MO... the first delivery considered ONE dataset (all three counties together). This delivery, however, was divided - Monroe/Audrain and Montgomery. In an effort to keep these counties as one complete dataset, LAS, DEMs, and QC points were combined. Certain documentation (i.e., metadata, Project, Acquisition), however, were supplied as separate entities or as a combination...and in this case, Accuracy has been reported by the contractor as Monroe/Audrain and Montgomery. Therefore, FVA reported accuracies are being reported an average. SVA and CVA are being reported as averages.

Accuracy values are reported in terms of Fundamental Vertical Accuracy (FVA), Supplemental Vertical Accuracy(s) (SVA), and Consolidated Vertical Accuracy (CVA).

Accuracy values are reported in:

Required FVA Value is   or less.

Target SVA Value is   or less.

Required CVA Value is   or less.

The reported FVA of the LAS Swath data is  .

The reported FVA of the Bare-Earth DEM data is  .

SVA are required for each land cover type present in the data set with the exception of bare-earth. SVA is calculated and reported as a 95th Percentile Error.

Land Cover Type	SVA Value	Units
Tall Weeds and Crops	<input type="text" value="19.5"/>	<input type="text" value="centimeters"/>
<i>Brush Lands and Low Trees</i>	<input type="text" value=""/>	<input type="text" value="N/A"/>
Forested Areas Fully Covered by Trees	<input type="text" value="22.3"/>	<input type="text" value="centimeters"/>
<i>Urban Areas with Dense Man-Made Structu...</i>	<input type="text" value=""/>	<input type="text" value="N/A"/>

The reported CVA of this data set is:  .

## LAS Swath File Review

LAS swath files or raw unclassified LiDAR data are reviewed to assess the quality control used by the data supplier during collection. Furthermore, LAS swath data are checked for positional accuracy. The data supplier should have calculated the Fundamental Vertical Accuracy using ground control checkpoints measured in clear open terrain. The following was determined for LAS swath data for this project:

### LAS Version

- LAS 1.2       LAS1.3       LAS 1.4

### Swath File Characteristics

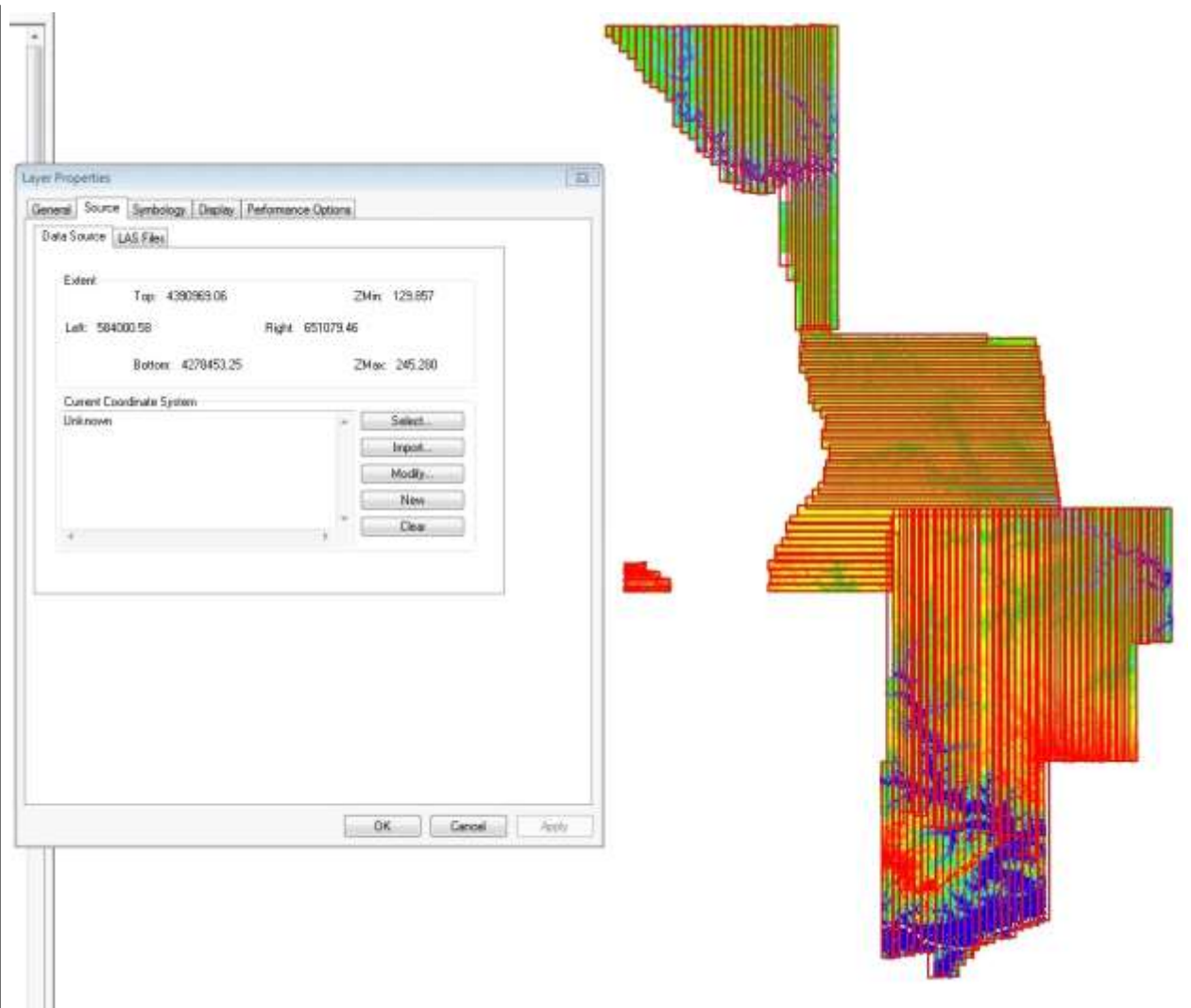
- Separate folder for LAS swath files  
 Each swath files <= 2GB  
 \*If specified, \*.wdp files for full waveform have been provided

The reported FVA of the LAS swath data is  .

Based on this review, the USGS does not accept at this time the LAS swath file data.

Errors, Anomalies, Other Issues to document?  Yes  No

Image?

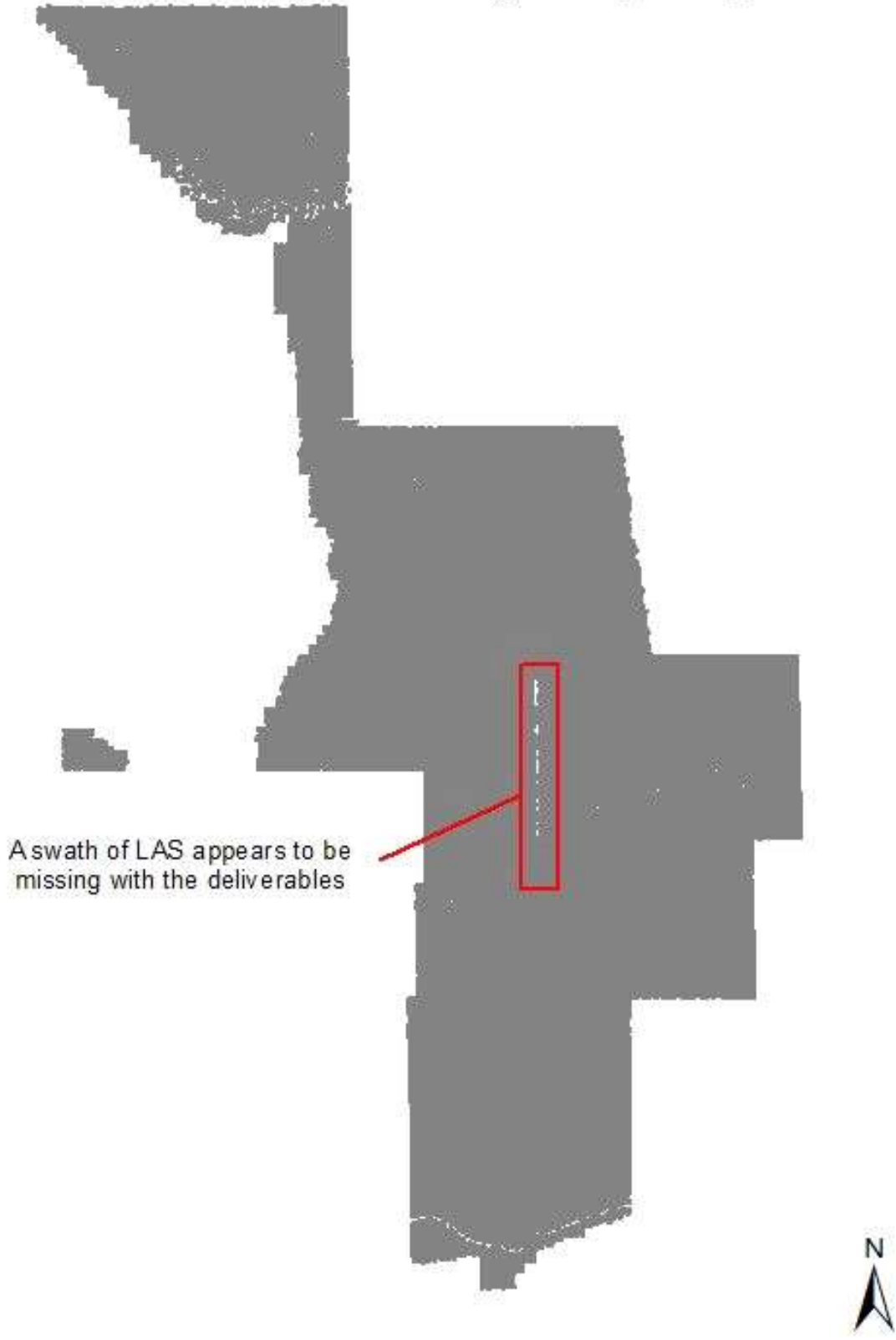


Swath LAS reads "Unknown Coordinate System".

\*\*Error corrected by contractor (5/31/2013).

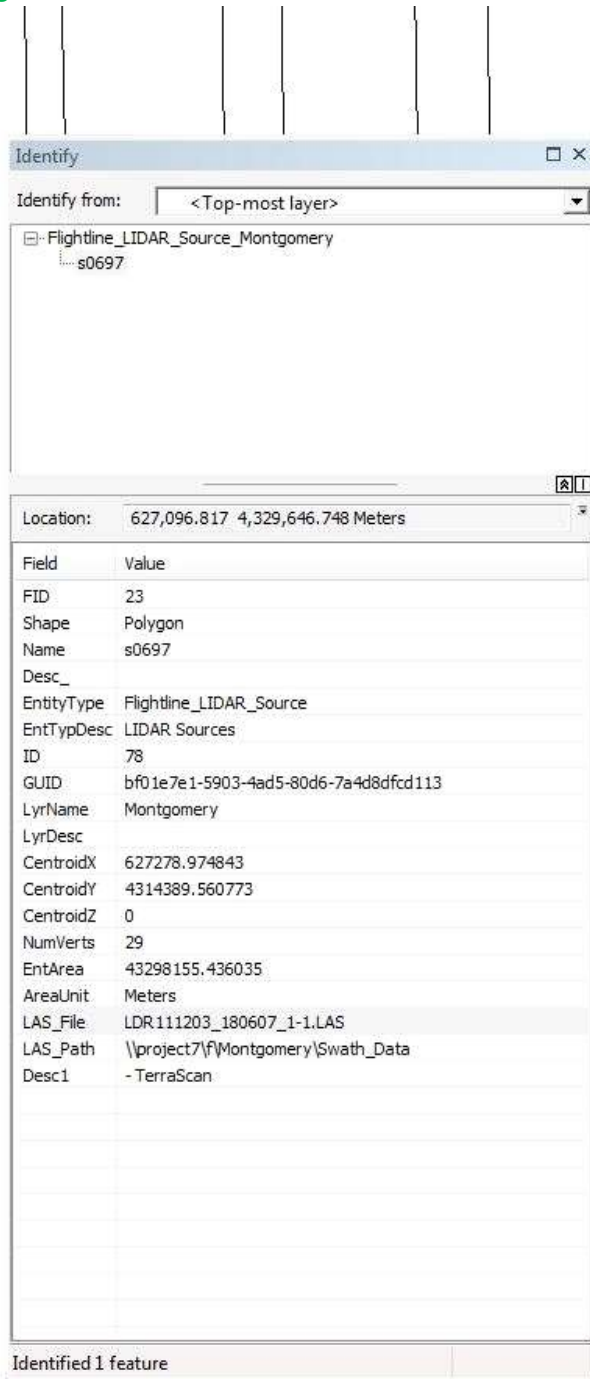
Image?

# MO\_MonroAudrainMontgomeryCos\_2011



One swath of LAS appears to be missing with the deliverables. Viewing the area in ArcMap, the gap TINs across the void.

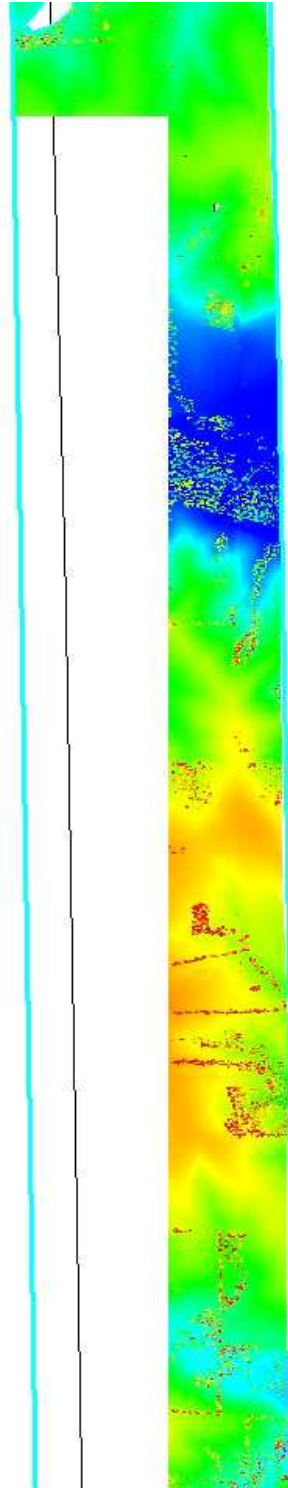
Image?



The screenshot shows the ArcMap Identify window with the following details:

- Identify from: <Top-most layer>
- Feature: Flightline\_LIDAR\_Source\_Montgomery (s0697)
- Location: 627,096.817 4,329,646.748 Meters
- Field Value table:

Field	Value
FID	23
Shape	Polygon
Name	s0697
Desc_	
EntityType	Flightline_LIDAR_Source
EntTypDesc	LIDAR_Sources
ID	78
GUID	bf01e7e1-5903-4ad5-80d6-7a4d8dfcd113
LyrName	Montgomery
LyrDesc	
CentroidX	627278.974843
CentroidY	4314389.560773
CentroidZ	0
NumVerts	29
EntArea	43298155.436035
AreaUnit	Meters
LAS_File	LDR111203_180607_1-1.LAS
LAS_Path	\\project7\F\Montgomery\Swath_Data
Desc1	- TerraScan
- Identified 1 feature



Swath LAS file LDR11203\_180607\_1 is missing points. This image shows the north-south flight line tiles and a LAS file which is missing points. The missing points are

part on Montgomery County, Missouri (2011).

\*\*This tile had been replaced by contractor - T Jerris 6/10/2012

## LAS Tile File Review

Classified LAS tile files are used to build digital terrain models using the points classified as ground. Therefore, it is important that the classified LAS are of sufficient quality to ensure that the derivative product accurately represents the landscape that was measured. The following was determined for classified LAS files for this project:

### Classified LAS Tile File Characteristics

- Separate folder for Classified LAS tile files
- Classified LAS tile files conform to Project Tiling Scheme
- Quantity of Classified LAS tile files conforms to Project Tiling Scheme
- Classified LAS tile files do not overlap
- Classified LAS tile files are uniform in size
- Classified LAS tile files have no points classified as '12'

- Point classifications are limited to the standard values listed below:

Code	Description
1	Processed, but unclassified
2	Bare-earth ground
7	Noise (low or high, manually identified, if needed)
9	Water
10	Ignored ground (breakline proximity)
11	Withheld (if the "Withheld" bit is not implemented in processing software)

- Buy up?

Based on this review, the USGS accepts the classified LAS tile file data.

Errors, Anomalies, Other Issues to document?  Yes  No

None.

## Breakline File Review

Breaklines are vector feature classes that are used to hydro-flatten the bare earth Digital Elevation Models.

### Breakline File Characteristics

- Separate folder for breakline files

- All breaklines captured as PolylineZ or PolygonZ features
- No missing or misplaced breaklines

Based on this review, the USGS accepts the breakline files.

Errors, Anomalies, Other Issues to document?  Yes  No

None.

## Bare-Earth DEM Tile File Review

The derived bare-earth DEM file receives a review of the vertical accuracies provided by the data supplier, vertical accuracies calculated by USGS using supplied and independent checkpoints, and a manual check of the appearance of the DEM layer.

Bare-Earth DEM files provided in the following format:

### Bare-Earth DEM Tile File Characteristics

- Separate folder for bare-earth DEM files
- DEM files conform to Project Tiling Scheme
- Quantity of DEM files conforms to Project Tiling Scheme
- DEM files do not overlap
- DEM files are uniform in size
- DEM files properly edge match
- Independent check points are well distributed

All accuracy values reported in .

### Reported Accuracies

Land Cover Category	# of Points	Fundamental Vertical Accuracy @95% Confidence Interval (Accuracy <sub>z</sub> ) Required FVA = 24.5 or less.	Supplemental Vertical Accuracy @95th Percentile Error Target SVA = 36.3 or less.	Consolidated Vertical Accuracy @95th Percentile Error Required CVA = 36.3 or less.
Open Terrain	<input type="text" value="64"/>	<input type="text" value="23.25"/>		
Tall Weeds and Crops	<input type="text" value="68"/>		<input type="text" value="19.5"/>	
Brush Lands and Low Trees	<input type="text" value=""/>		<input type="text" value=""/>	
Forested Areas Fully Covered by Trees	<input type="text" value=""/>		<input type="text" value="22.3"/>	
Urban Areas with Dense Man-Made Structures	<input type="text" value=""/>		<input type="text" value=""/>	
Consolidated				

132

20.45

 QA performed Accuracy Calculations?

**Calculated Accuracies**

Land Cover Category	# of Points	Fundamental Vertical Accuracy @95% Confidence Interval (Accuracy <sub>z</sub> ) Required FVA = 24.5 or less.	Supplemental Vertical Accuracy @95th Percentile Error Target SVA = 36.3 or less.	Consolidated Vertical Accuracy @95th Percentile Error Required CVA = 36.3 or less.
Open Terrain	64	23.3		
Tall Weeds and Crops	68		19.53	
<i>Brush Lands and Low Trees</i>	↓		↓	
Forested Areas Fully Covered by Trees	64		22.3	
<i>Urban Areas with Dense Man-Made Structures</i>	↓		↓	
Consolidated	196			21.1

Based on this review, the USGS recommends the bare-earth DEM files for inclusion in the 1/3 Arc-Second National Elevation Dataset.

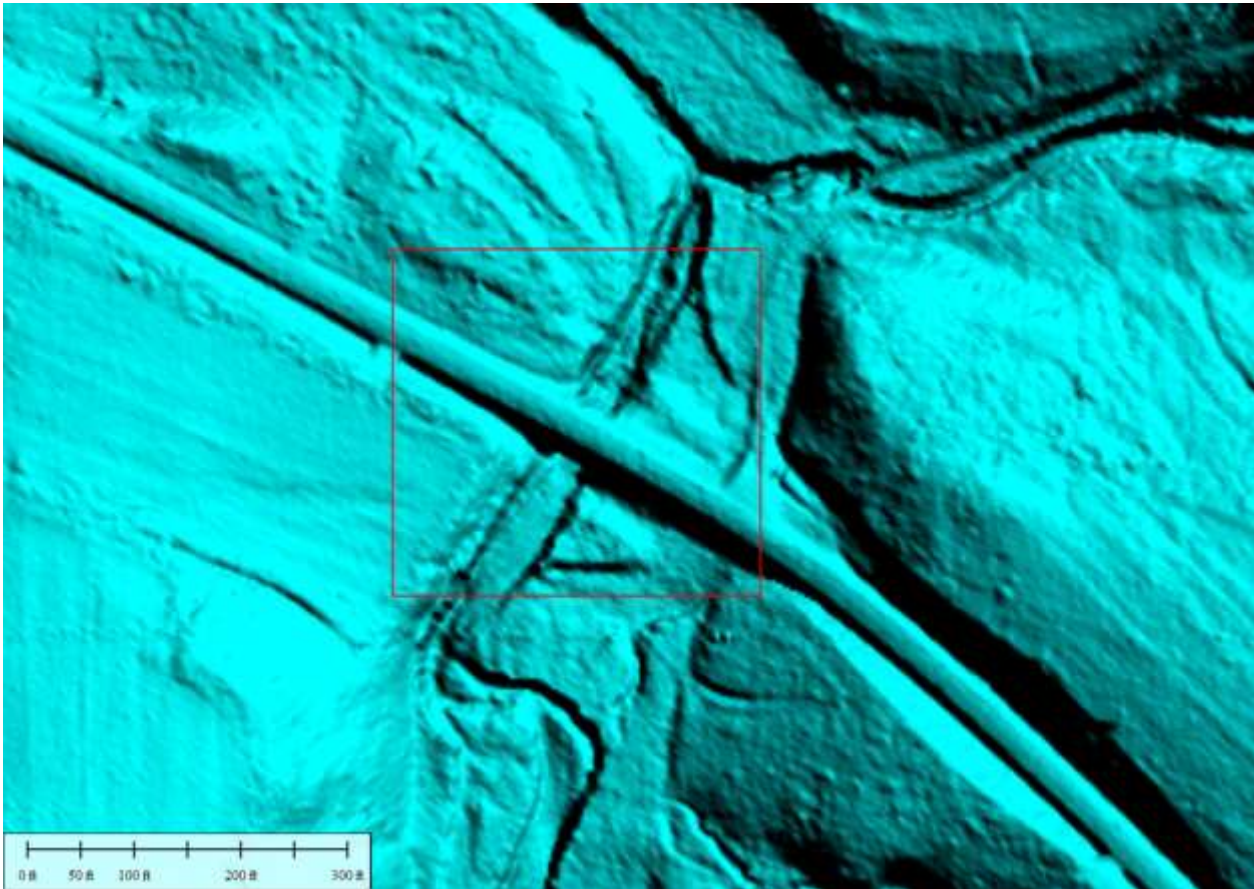
Based on this review, the USGS accepts the bare-earth DEM files.

## Bare-Earth DEM Anomalies, Errors, Other Issues

 Errors, Anomalies, Other Issues to document?  Yes  No

 Image?

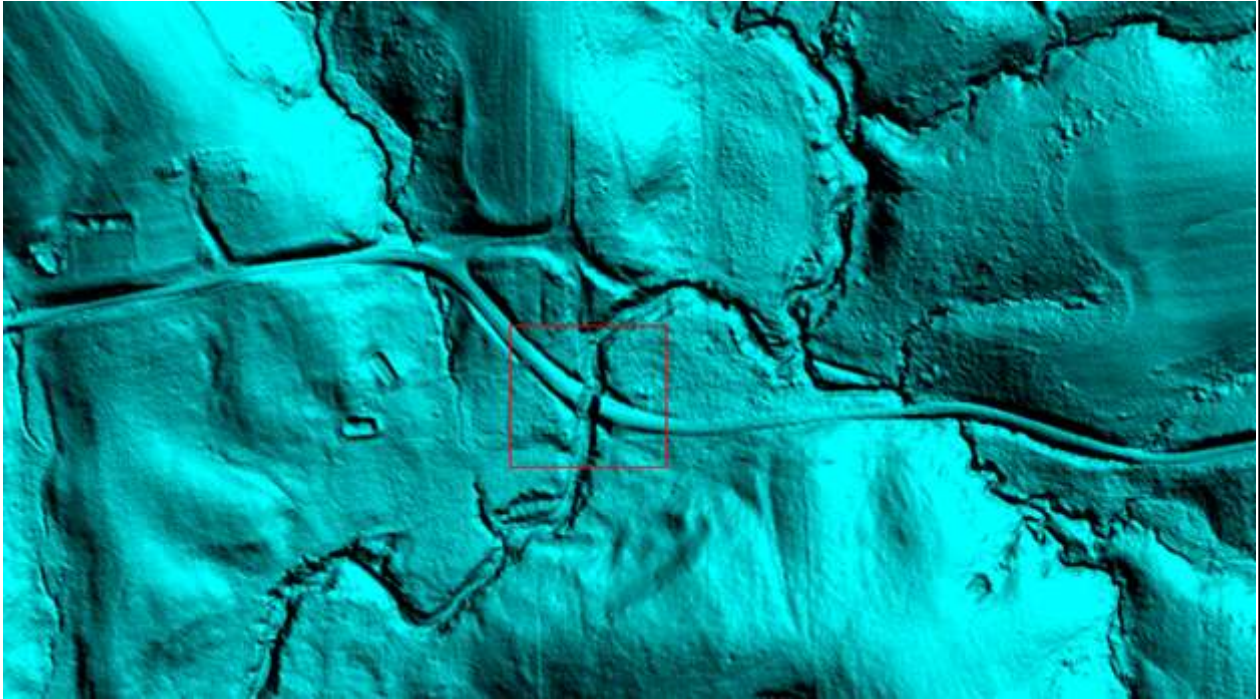




bridge: Imagery suggests the roadway above the waterbody (stream) is a bridge; roadway above waterbody should be removed. There are two of this error-type

\*\*These errors have been corrected by the contractor (5/31/2013).

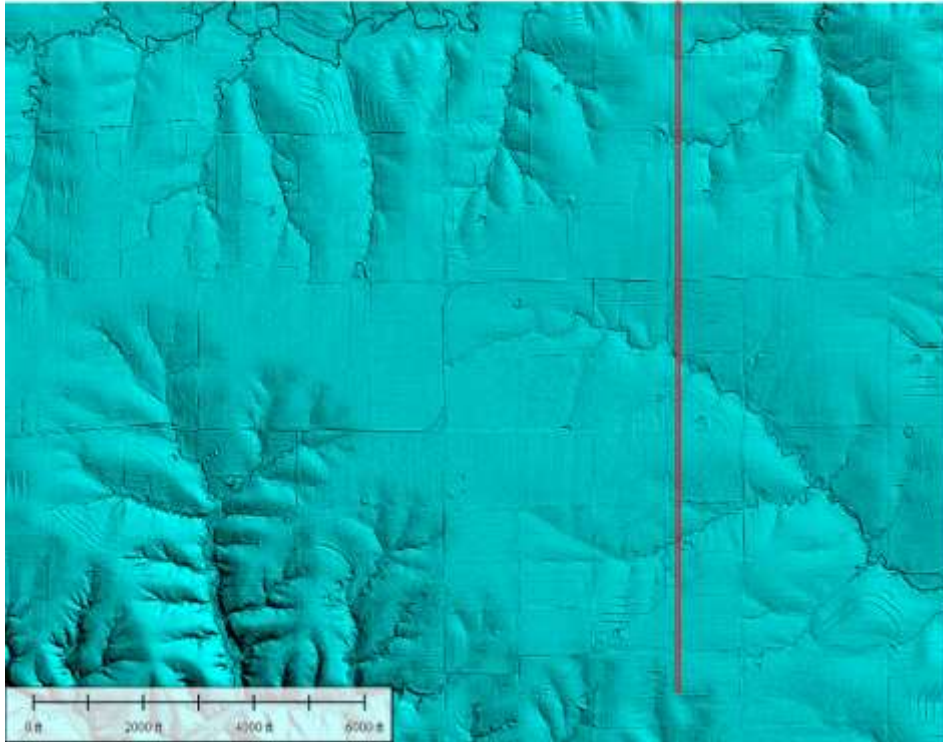
Image?



culvert\_1: This is a representative image of the error-type 'culvert', whereas the roadway was removed above a waterbody (stream). Roadways above culverts should not be removed. 104 culvert-errors have been identified within this dataset.

\*\*These errors have been corrected by the contractor (5/31/2013).

Image?

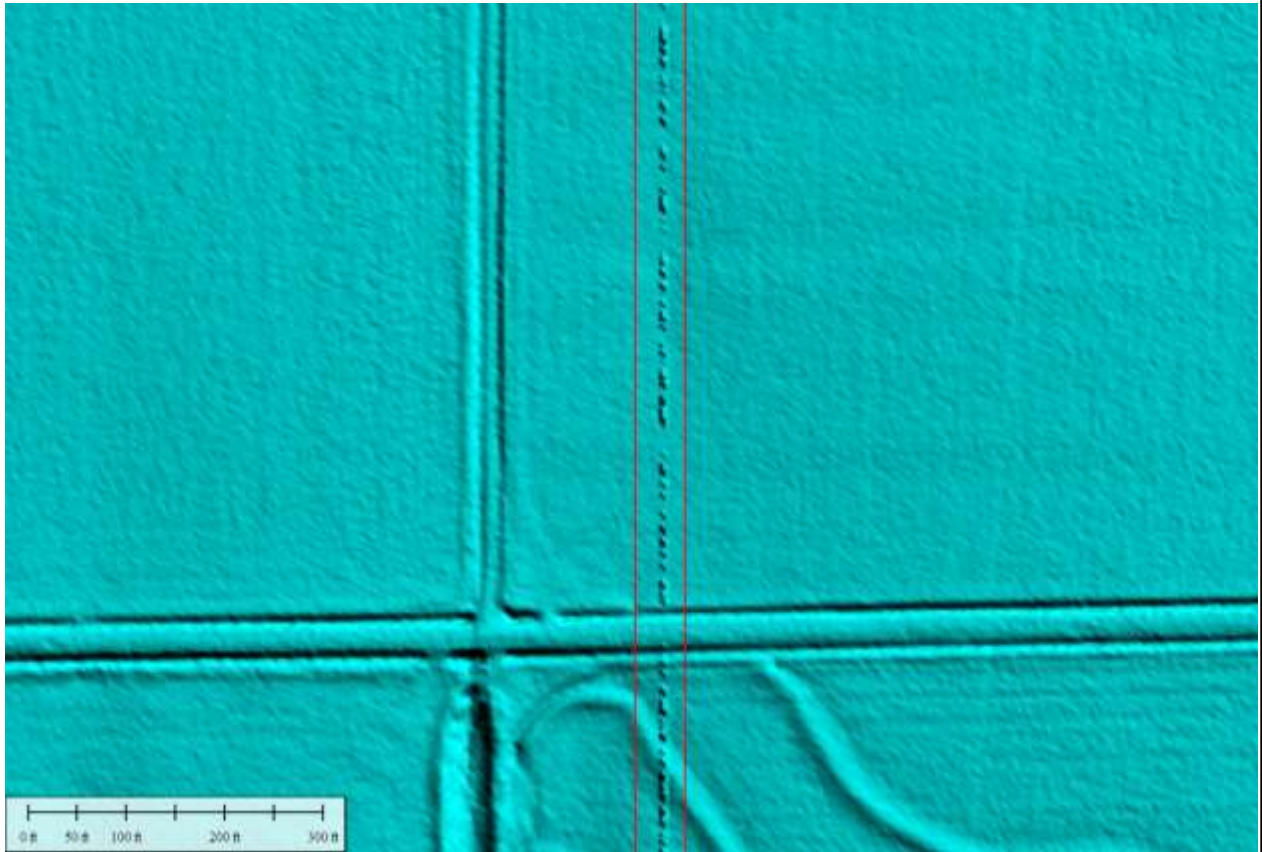


linear\_anomaly: The area in red shows the extent of a north-south trending anomaly within the DEM. The image below shows in detail this lineation. There are two of this error-type. Both errors follow the same longitude.

\*\*These errors have been corrected by the contractor (5/31/2013).

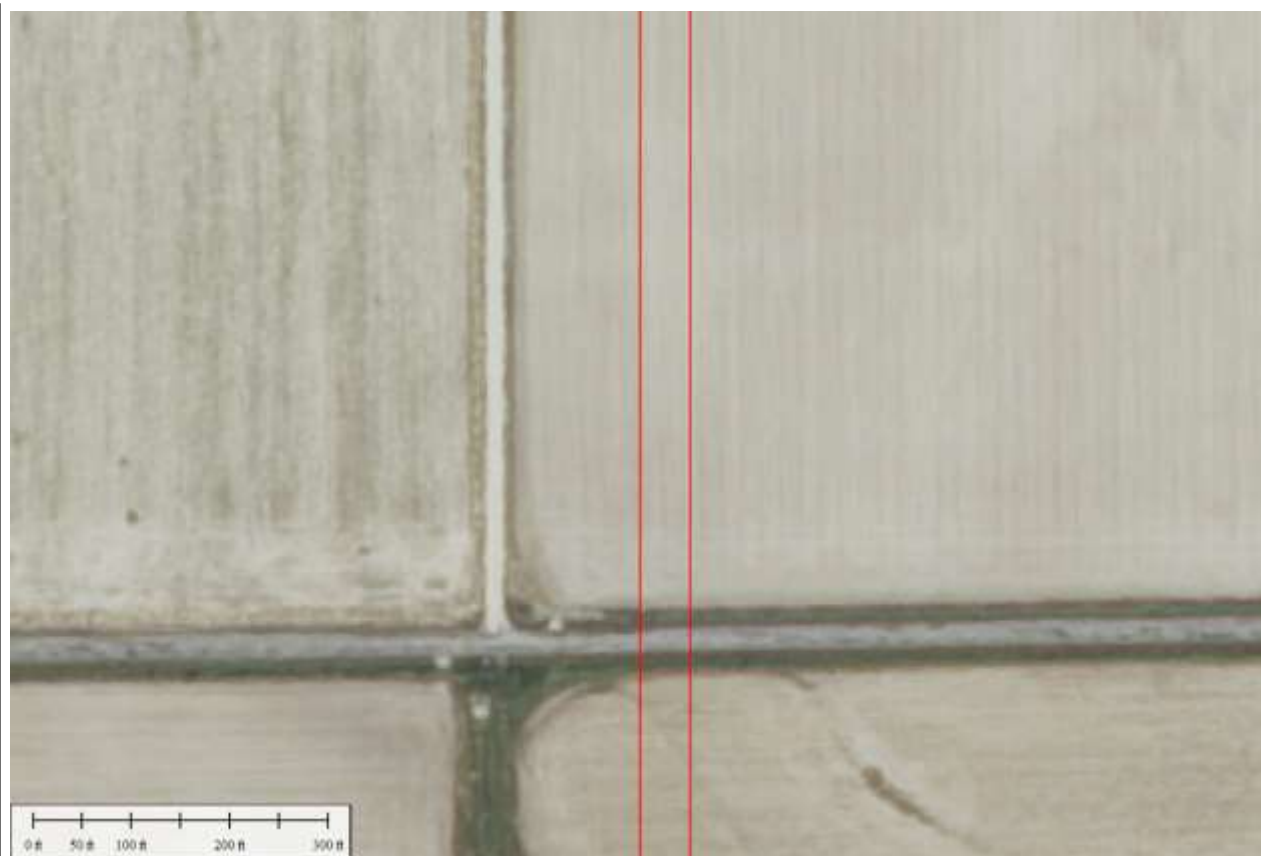
Image?





linear\_anomaly\_close-up: This image clearly shows the linear anomaly in the DEM.

Image?



linear\_anomaly\_close-up\_NAIP: This NAIP image shows the same area of the image above. The lineation does not appear to be natural but a DEM processing error.

Internal Note:

Errors associated with first delivery:

2 @ bridge removals (...roadway should be removed)

104 @ roadways removed above culverts (...roadways should not be removed above them)

2 @ DEM area lineations (anomalies); areas are narrow, run north-south, and are adjacent (north-south) from each other.

1 @ Swath LAS file missing

All Swath files have no coordinate system in header

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\*\*6/3/2013

Swath LAS file LDR111208\_143323\_1 is missing points. The project is recommended for the NED, however, the swath LAS is rejected due to missing points. An image of this error can be viewed above - in the LAS Swath File Review section of this report.

\*\*6/10/2013

Swath LAS file LDR111208\_143323\_1 has been resubmitted, verified by NGTOC, and accepted.

**This is the end of the report.**

QA Form V1.4 12OCT11.xsn