



# 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:

5/1/2012

Project Type: Partnership

Project ID:

KS\_3County\_2010

Project Description:

This county is part of a 4 county USGS agreement with Kansas (Harvey, Lyon, Morris and Chase Co.). 11 more counties were delivered with the lot as donated data. Three reports will be delivered for the 15 counties - One for Harvey Co. (lot 1), 1 for Lyon, Morris and Chase Cos. (lot 2) and 1 for the remaining 11 counties (lot 3).

Project Alias(es):

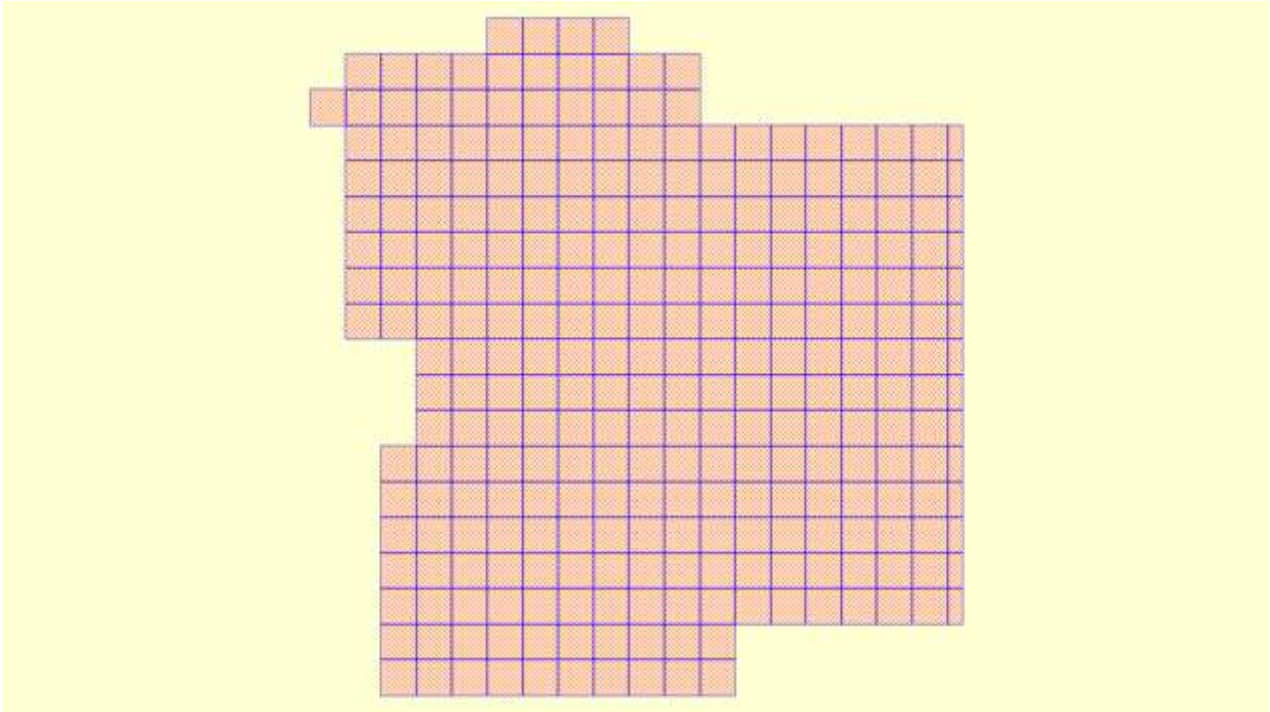
KS 15 County dataset

Year of Collection: 2010-11

Lot 2 of 3 lots.

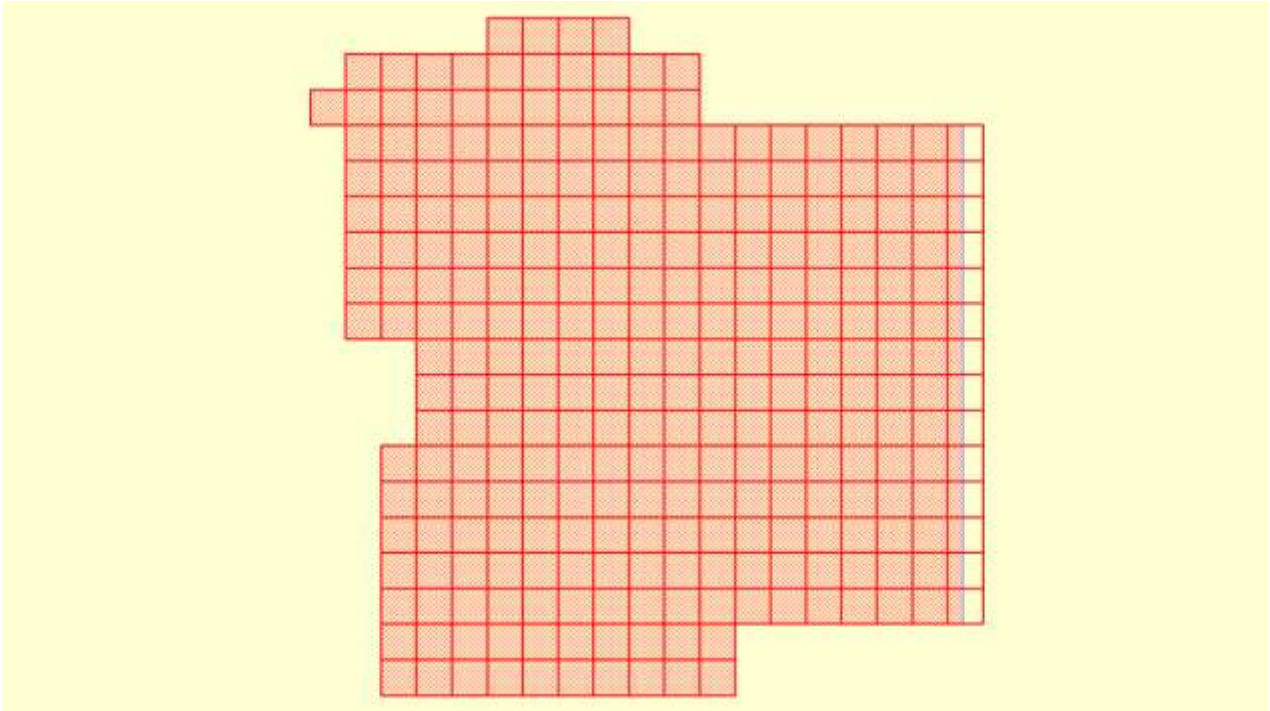
Project Extent:

Project Extent image?



Project Tiling Scheme:

Project Tiling Scheme image?



Contractor:

Kucera

Applicable Specification:

V13

Licensing Restrictions:

Third Party Performed QA?

Project Points of Contact:

POC Name	Type	Primary Phone	E-Mail
Ingrid Landgraf	NSDI Liaison	785-832-3566	imlandgraf@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
- Project Tiling Scheme Shapefile/Gdb
- Control Point Shapefile/Gdb
- Breakline Shapefile/Gdb
- Project XML Metadata

## Multi-File Deliverables

File Type	Quantity
<input checked="" type="checkbox"/> Swath LAS Files <input checked="" type="checkbox"/> Required? <input checked="" type="checkbox"/> XML Metadata?	520
<input type="checkbox"/> Intensity Image Files <input type="checkbox"/> Required?	
<input checked="" type="checkbox"/> Tiled LAS Files <input checked="" type="checkbox"/> Required? <input checked="" type="checkbox"/> XML Metadata?	309
<input checked="" type="checkbox"/> Breakline Files <input checked="" type="checkbox"/> Required? <input checked="" type="checkbox"/> XML Metadata?	3
<input checked="" type="checkbox"/> Bare-Earth DEM Files <input checked="" type="checkbox"/> Required? <input checked="" type="checkbox"/> XML Metadata?	309

## Additional Deliverables

Errors, Anomalies, Other Issues to document?  Yes  No

The swath files were not separated by county. The 520 files are for all 15 counties and Dodge City, KS data.

# Project Geographic Information

Areal Extent:

2760.6

Sq Mi

Grid Size:

1

meters

Tile Size:

5000 x 5000

meters

Nominal Pulse Spacing:

Select...

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 type="checkbox"/> Checkpoints Shapefile/Geodatabase              | <input checked="" 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:

L. Lansbery

Review Start Date:

6/4/2012

Action to Contractor Date	Issue Description	Return Date
6/12/2012	Errors in DEM, classified las, breaklines	9/5/2012
10/16/2012	Missing data area, elevated water errors, removal of culverts, area where road not removed.	11/7/2012

Review Complete: 11/26/2012

## 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

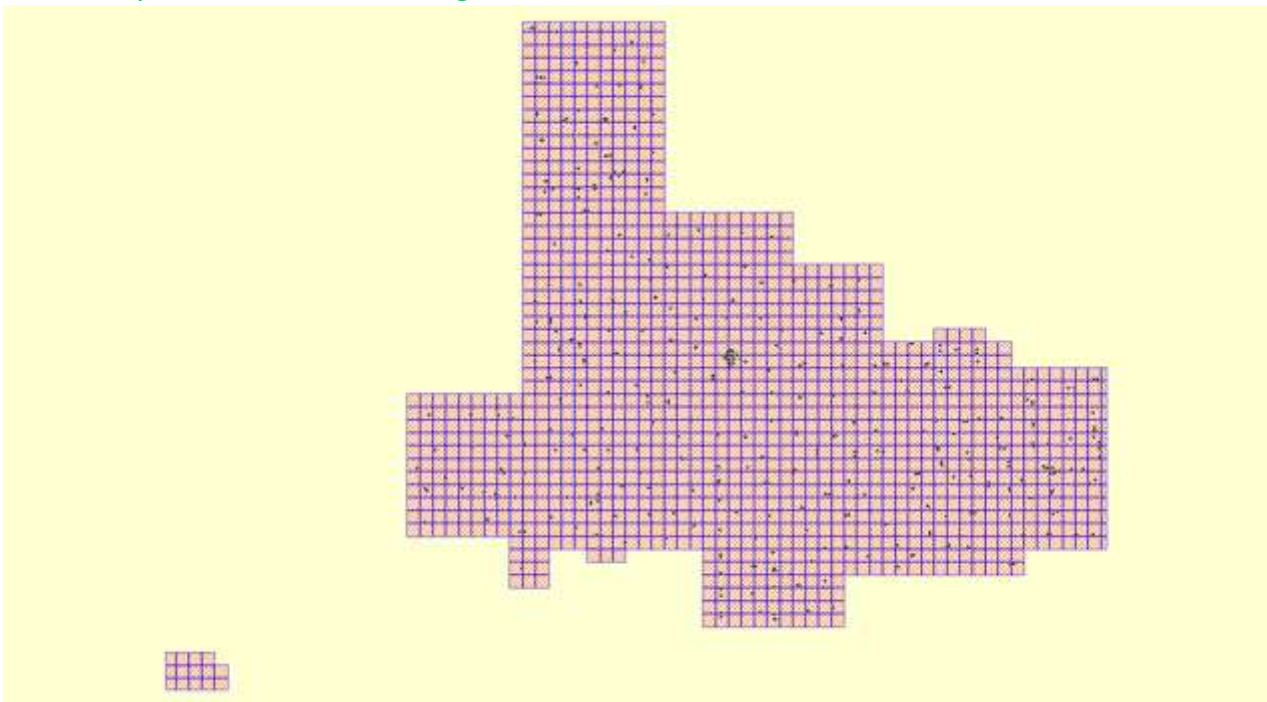
ASPRS recommends that checkpoint surveys be used to verify the vertical accuracy of LiDAR data sets. Checkpoints are to be collected by an independent survey firm licensed in the particular state(s) where the project is located. While subjective, checkpoints should be well distributed throughout the 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.

No shapefile of checkpoints was provided to USGS  Yes  No

Image?

From Survey Report: For the land cover accuracy checkpoint survey the project area was divided into 12 contiguous area "blocks" (FEMA01 – FEMA12), each covering approximately 1000 square miles. For each significant land cover type within each block, at least 20 ground checkpoints spread through the cover type were surveyed. The land covers surveyed in each block were brushlands/low trees (BR), high grass/weeds/crops (HG), and bare earth/low grass/pavement (BE).

Chase, Morris and Lyon counties encompass blocks FEMA01, FEMA02, FEMA03. Each report their own vertical accuracy results:  
FEMA01: FVA=10cm; SVA=25.3cm (High Grass) and 15.5cm (Brush); CVA=18.3cm  
FEMA02: FVA=11.6cm; SVA=22.7cm (High Grass) and 25cm (Brush); CVA=24.3cm  
FEMA03: FVA=19.4cm; SVA=16.6cm(High Grass) and 17.6cm (Brush); CVA=17.1cm

\*\*Vertical Accuracy was calculated on the entire project and the overall results will be listed in all three lot reports. A total of 814 checkpoints were included for the entire project.

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="30.5"/>	<input type="text" value="centimeters"/>
Brush Lands and Low Trees	<input type="text" value="27.7"/>	<input type="text" value="centimeters"/>
<i>Forested Areas Fully Covered by Trees</i>	<input type="text" value=""/>	<input type="text" value="centimeters"/>
Urban Areas with Dense Man-Made Structu...	<input type="text" value="05.9"/>	<input type="text" value="centimeters"/>

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 accepts the LAS swath file data.

Yes  No

None.

## 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)

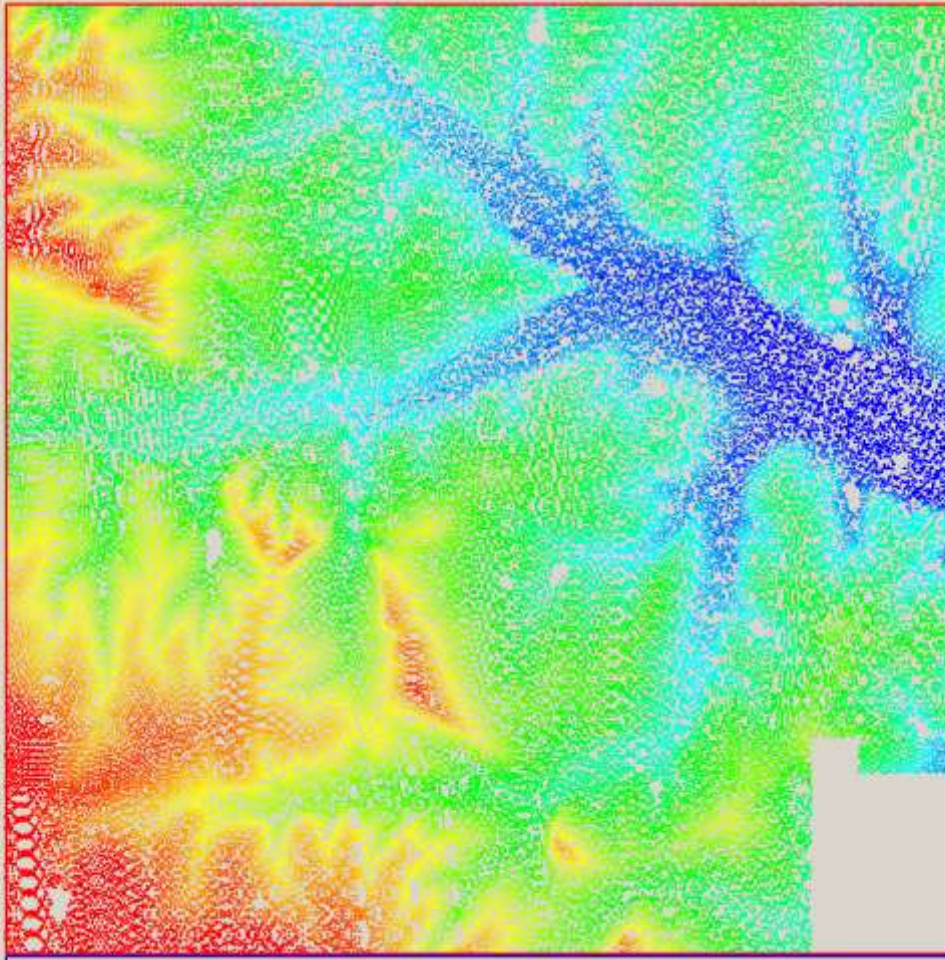
- Buy up?

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

Missing points in the las file, NoData areas in DEM that are classified as ground in las.

- Yes  No

- Image?

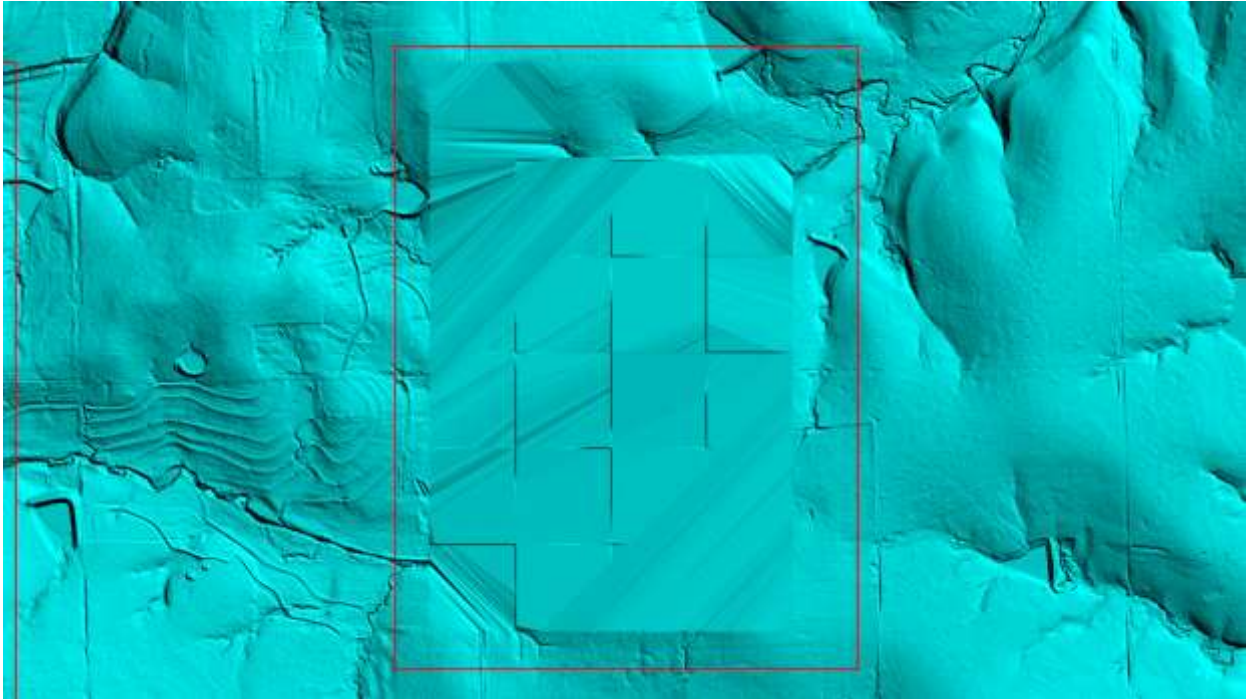


area of missing points resulting in triangulated area. LAS\_14SQH0570. See picture below.

\*\*Corrected by vendor.

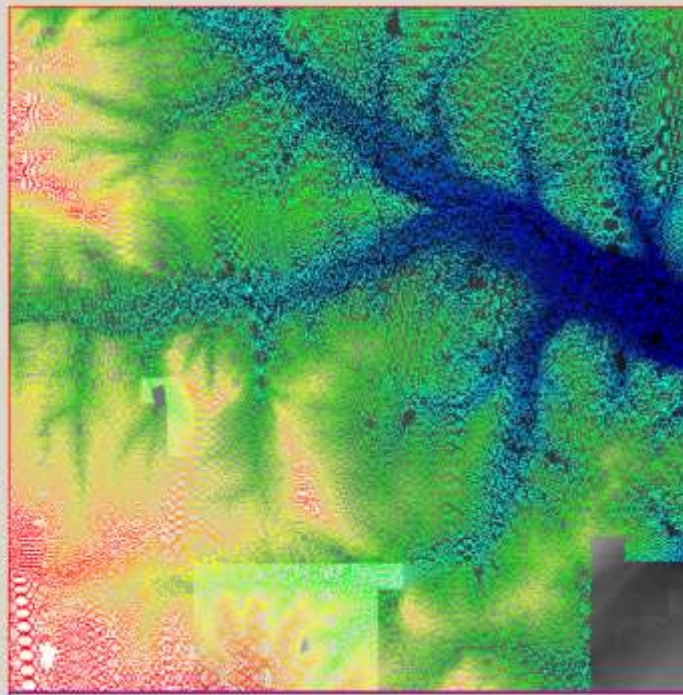
Image?





Location at 38° 33' 32.3750" N, 96° 35' 38.7736" W

Image?

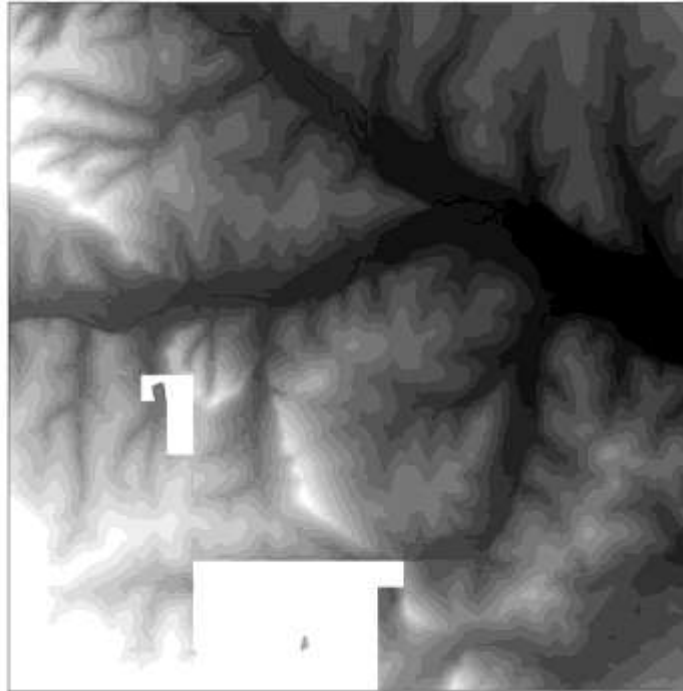


BE image overlain by las tile. Two other area are NoData area and can be seen in the lower and middle portions of tile. See picture below.

\*\*Two areas were fixed by vendor, however the missing data in the las tile and the

resulting tinning in the DEM were not fixed. A check of the swath data shows there are points in this area (see below)\*\*

Image?



BE\_14SQH0570.

\*\*These two area were fixed by vendor\*\*

Image?

Other classes include: Class 17: overlap unclassified, Class 18: overlap bare-earth ground, Class 23: overlap noise, Class 24: overlap water per the metadata.

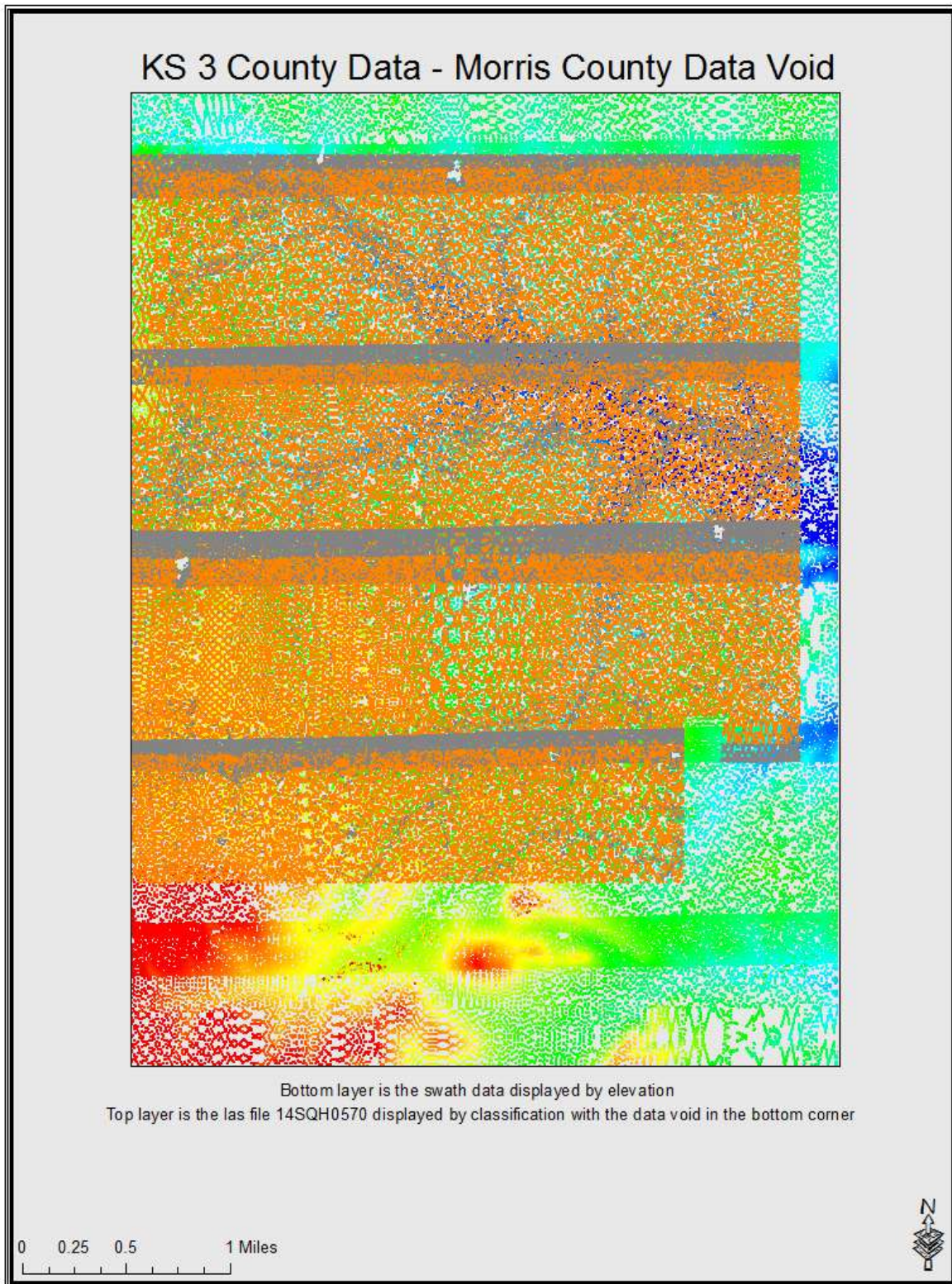
During las check: Class 23 not found

For each las tile ERROR-->The System ID is required and NOTICE-->File Source ID is not assigned.

Many las tiles returning errors for header-Point coordinate mismatch, Point(s) found with bad GPS Time



Image?



The swath tile that encompasses the data void area is 04801.

## 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.

Yes  No

## 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	<u>Fundamental Vertical Accuracy @95% Confidence Interval (Accuracy<sub>z</sub>)</u> Required FVA = 24.5 or less.	<u>Supplemental Vertical Accuracy @95th Percentile Error</u> Target SVA = 36.3 or less.	<u>Consolidated Vertical Accuracy @95th Percentile Error</u> Required CVA = 36.3 or less.
Open Terrain	20	19.2		
Tall Weeds and Crops	1		30.5	
Brush Lands and Low Trees	1		27.7	
<i>Forested Areas Fully Covered by Trees</i>	1		1	
Urban Areas with Dense Man-Made Structures	1		05.9	
Consolidated	20			

QA performed Accuracy Calculations?

### Calculated Accuracies

Land Cover Category	# of Points	<u>Fundamental Vertical Accuracy @95% Confidence Interval (Accuracy<sub>z</sub>)</u> Required FVA = 24.5 or less.	<u>Supplemental Vertical Accuracy @95th Percentile Error</u> Target SVA = 36.3 or less.	<u>Consolidated Vertical Accuracy @95th Percentile Error</u> Required CVA = 36.3 or less.
Open Terrain	272	14.0		
Tall Weeds and Crops	266		30.775	
Brush Lands and Low Trees	256		26.725	
<i>Forested Areas Fully Covered by Trees</i>	1		1	
Urban Areas with Dense Man-Made Structures	20		05.185	
Consolidated	814			26.7

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?

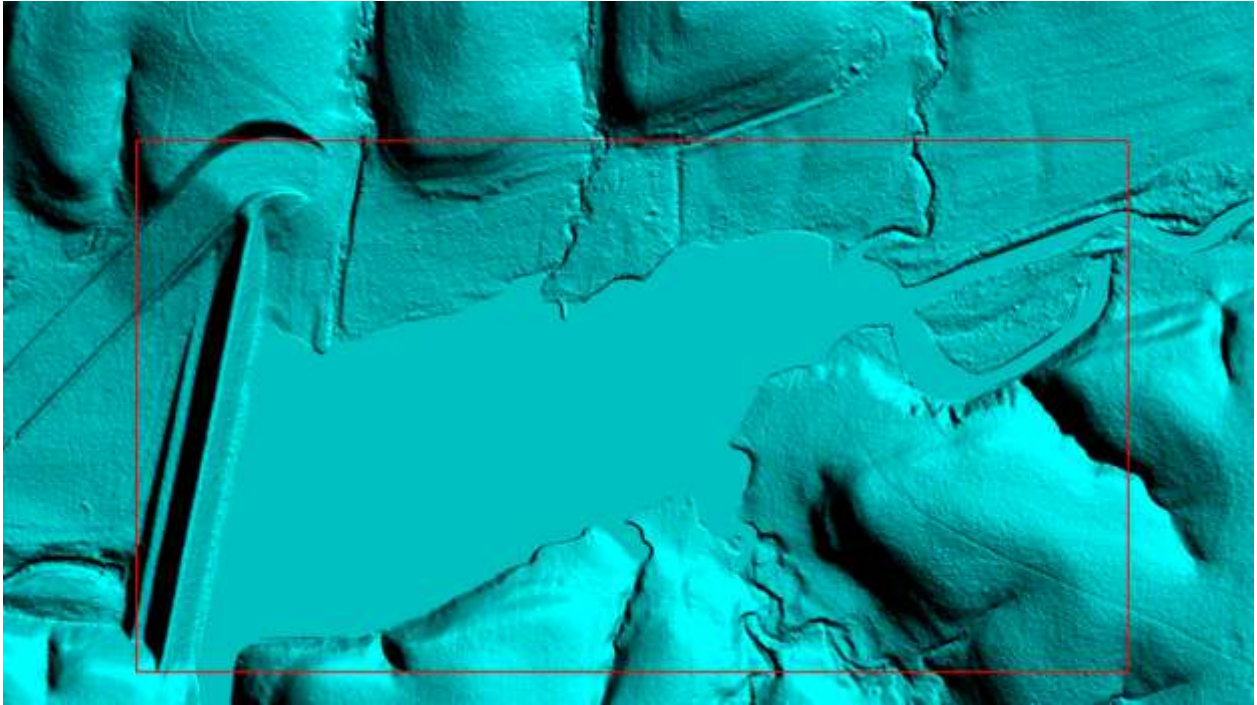
NPS is not stated in the metadata.

Image?

No shapefile of checkpoints provided. Due to project being broken up into 3 lots by counties, a shapefile of points is needed in order to do vertical accuracy assessment.

\*\*A shapefile was created at NGTOC of all the checkpoints in the 15 county project\*\*

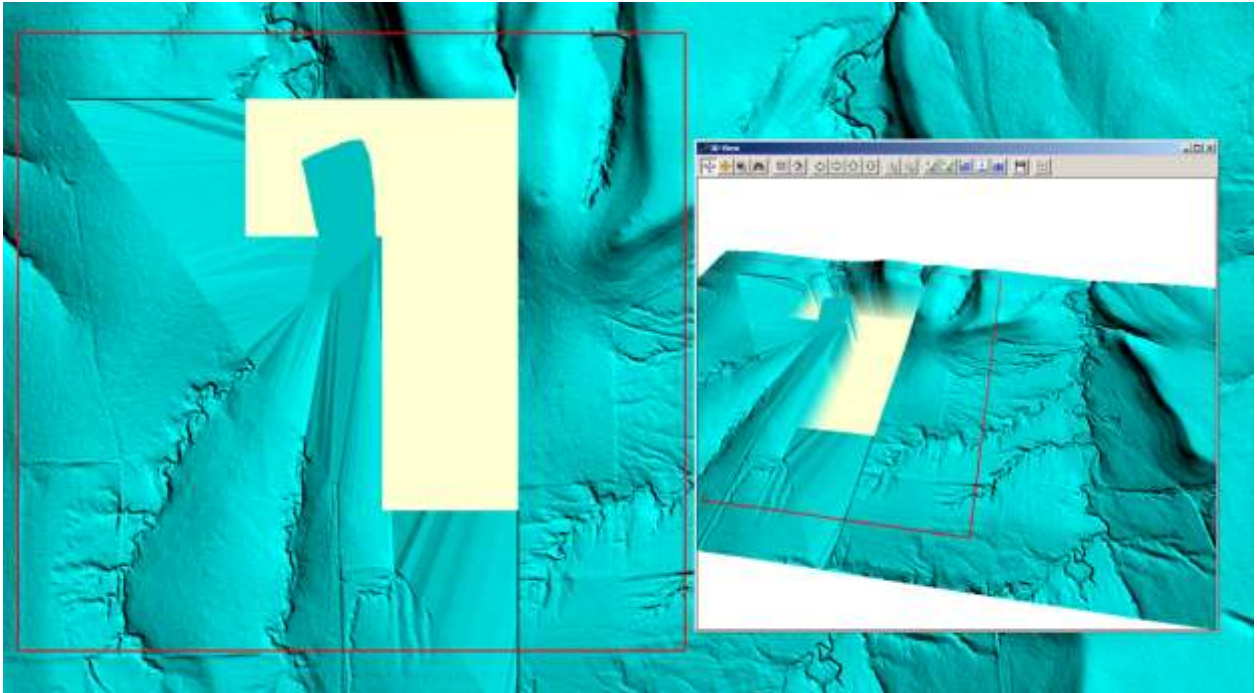
Image?



Several errors with water higher than the surrounding land. This is only a representative image. Not all these errors were recorded due to the high number found within the dataset. Location of this error at 38° 06' 31.2867" N, 96° 29' 6.3442" W

**\*\*These areas were fixed by vendor\*\***

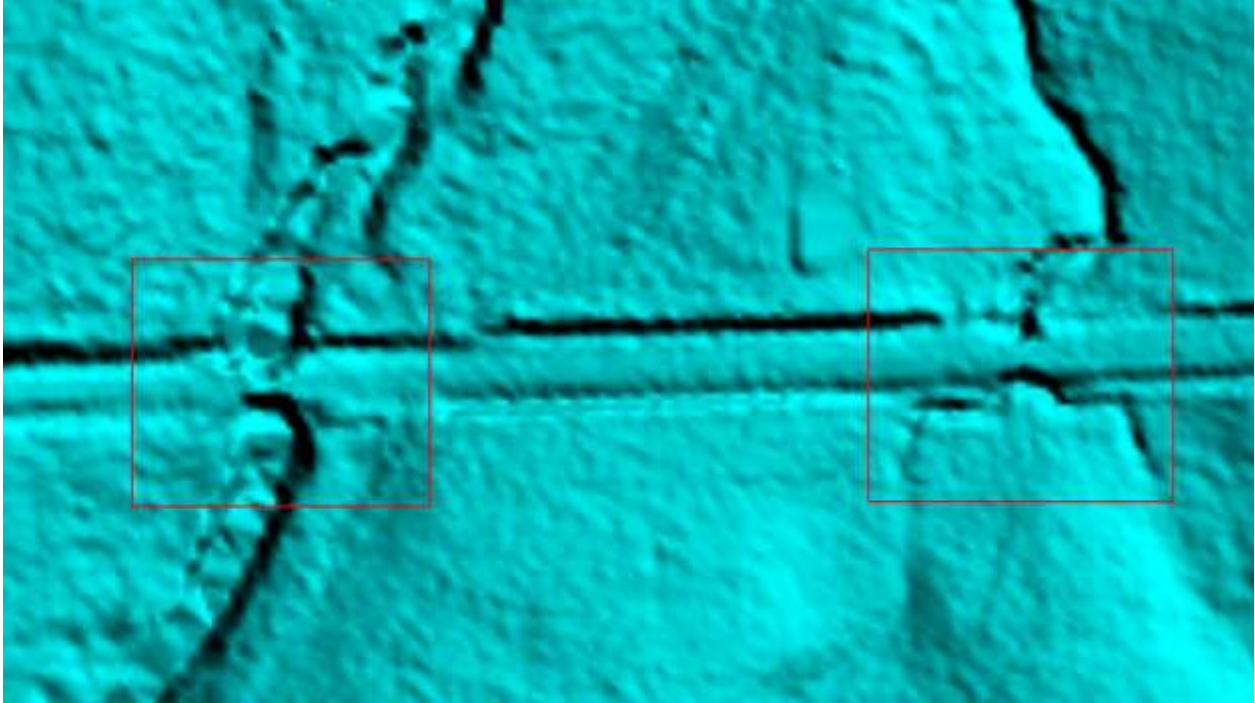
Image?



Data void areas mentioned above in classified las section. This displays a 3-D image to show what is happening in the DEM. Location at 38° 34' 24.1083" N, 96° 37' 58.6853" W

**\*\*Vendor fixed this error\*\***

Image?

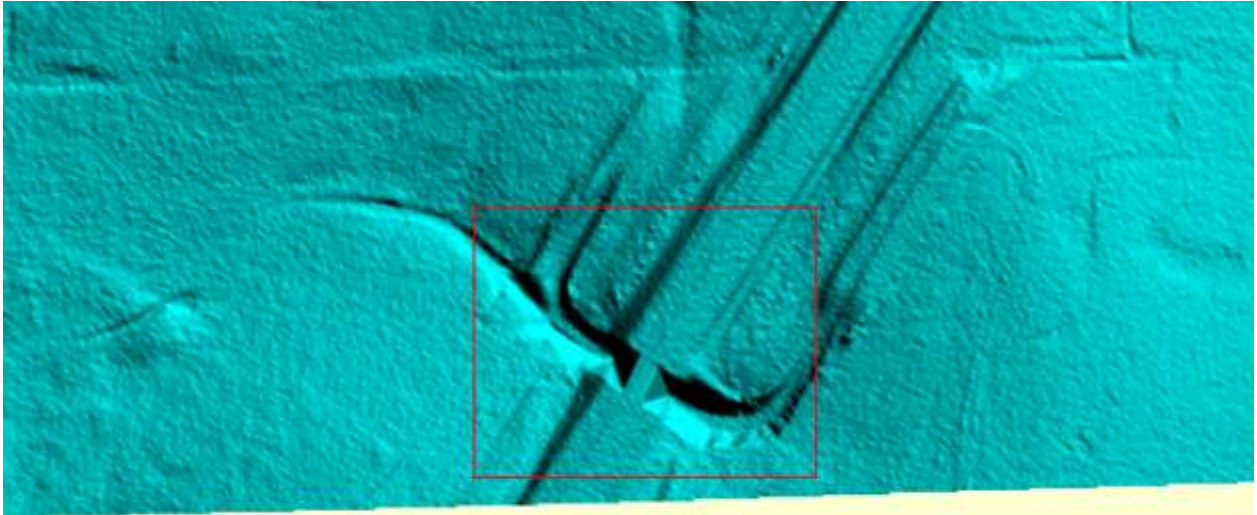


As with Harvey Co., several errors exist in dataset in which culverts were removed completely or partially as seen above when they should be left in data. This is a representative image of the errors. Only a few of this type of error were called due to it being endemic throughout. Location at 38° 05' 8.1436" N, 96° 49' 17.6969" W

**\*\*Most of the culvert areas were fixed. 3 remain in which a culvert was removed partially\*\***

Image?

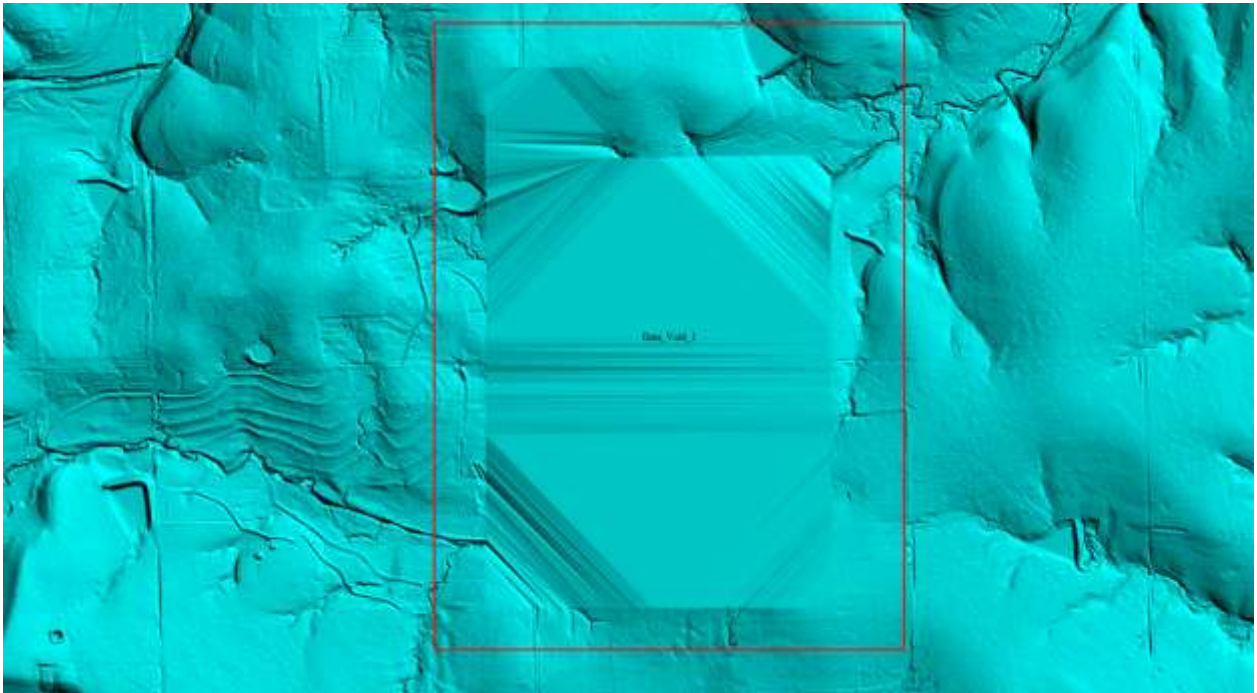




Bridge removal that is incomplete. This error type is endemic throughout the dataset. Location at 38° 05' 5.6862" N, 96° 35' 12.6957" W

**\*\*Vendor fixed these errors that were called by QA Reviewer\*\***

Image?



The data void area was not corrected and still remains in the DEM and las.

\*\*Corrected by vendor.

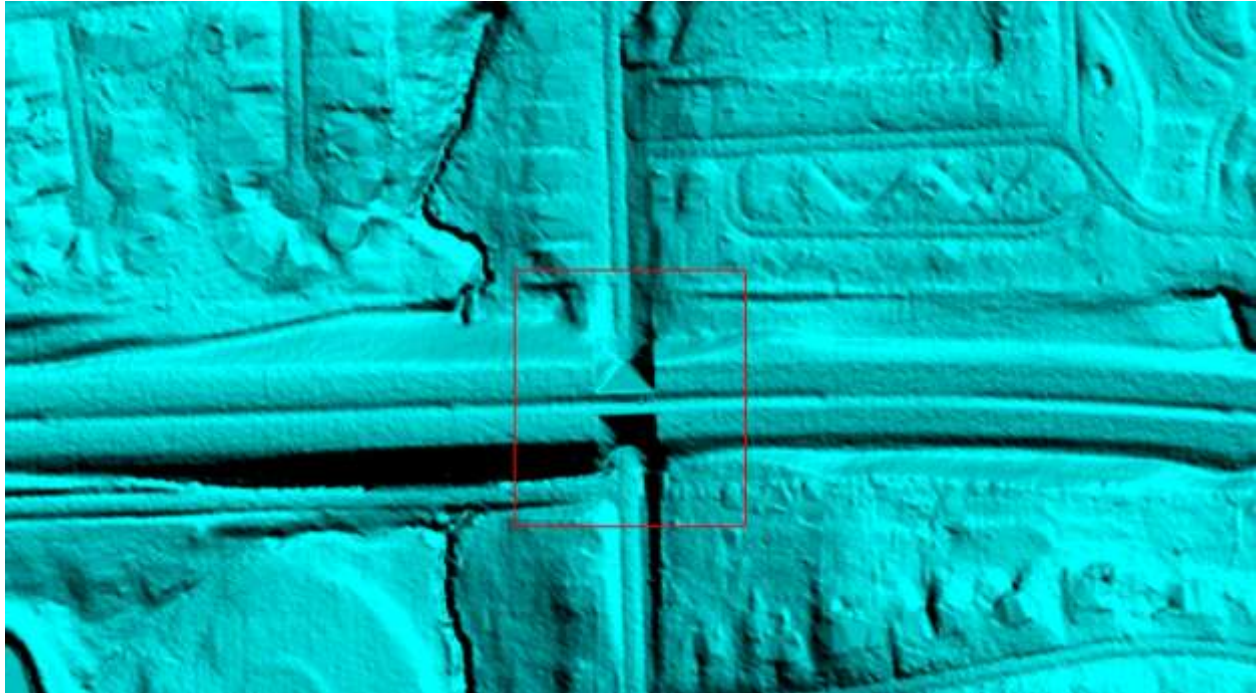
Image?



3 errors remain where the water is elevated higher than the land. This is only a representative image.

\*\*Corrected by vendor.

Image?



This is a tunnel that has not been completely removed. Location at 38° 25' 37.8678" N, 96° 11' 54.4770" W

\*\*Corrected by vendor.

Internal Note:

3 County (Lyon, Morris and Chase Co., KS is part of a larger project called KS\_15County\_2010 and represents Lot 2 of 3. Lots 1 and 2 are partnership data. The other 11 counties are donated data and will be Lot 3 (KS\_11Counties\_2010). Swath data is not broken up by county and will be provided in Lot 3. The .las files were broken up by county, but not the metadata, therefore .las will be provided in Lot 3 along with the metadata files. A best-use metadata file is provided in Lots 1 and 2 for the bare earth DEM files and las. A project level breaklines metadata file is also provided for all the lots, however, a separate breakline file is provided for each county.

The checkpoints were separated by FEMA blocks, each covering about 1000 square miles, and not by county. Due to this, vertical accuracy was ran on the entire project at once and the results are reported in each lot. The FVA was checked on the swath data with a result of 14.8 cm.

Several errors existed in the dataset that were corrected by the vendor.

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

QA Form V1.4 12OCT11.xsn