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 NGTOCoperations@usgs.gov.

Materials Received:
4/2/2013

Project ID:
AK_MatanuskaSusitna-Lot2_2012

Project Alias(es):
MatSu

Project Type: NSDI Agreement

Project Description:
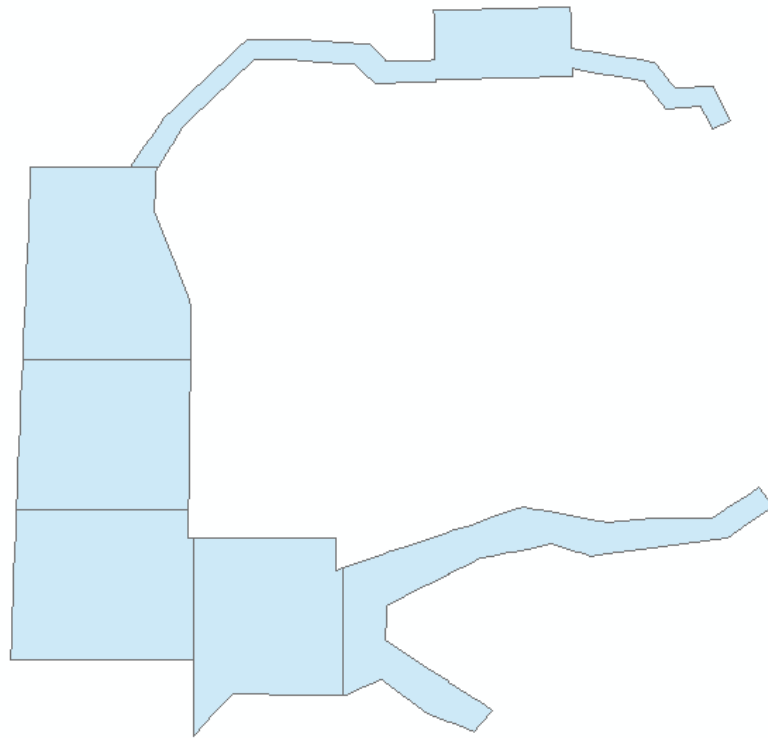Delivery of remainder of project area.

Year of Collection: 2012
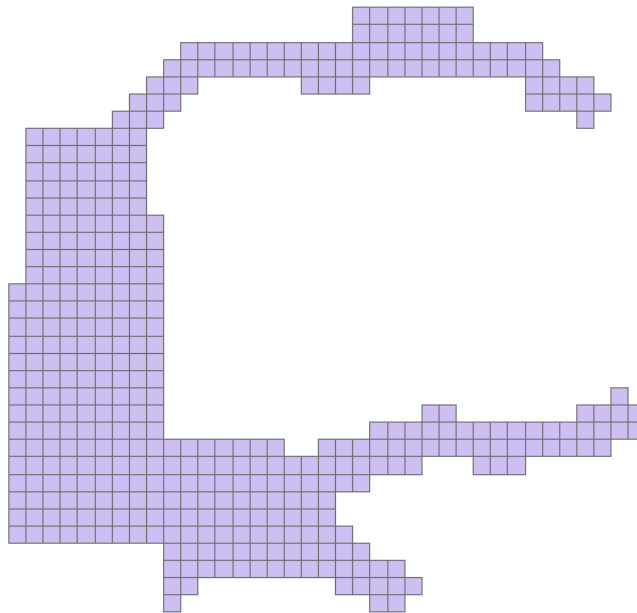
Lot 2 of 2 lots.

Project Extent:
☑ Project Extent image?

Project Tiling Scheme:
☑ Project Tiling Scheme image?

Contractor:

Aerometric, Inc.

Applicable Specification:

V13; FEMA Memorandum 61

Licensing Restrictions:

None

☑ Third Party Performed QA?

Third Party QA Performed By:

Lounsbery and Associates, Inc; Alaska Satellite Facility of the Geophysical Institute at UAF.

Project Points of Contact:

POC Name	Type	Primary Phone	E-Mail
Becci Anderson	NSDI Liaison	907-786-7042	rdanderson@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
☑ Swath LAS Files ☑ Required? ☑ XML Metadata?	1425
☑ Intensity Image Files ☑ Required?	1520
☑ Tiled LAS Files ☑ Required? ☑ XML Metadata?	1520
☑ Breakline Files ☑ Required? ☑ XML Metadata?	4
☑ Bare-Earth DEM Files ☑ Required? ☑ XML Metadata?	424

Additional Deliverables

	Item
☑	Building footprints in geodatabase and shapefile format.
☑	2, 10, 20, 50, and 100 foot contours in geodatabase, shapefile, and dxf format.
☑	First return DSM in tif format, with xml metadata for each tif file.
☑	Hillshades for both bare-earth and first-return surfaces in tif format.

Errors, Anomalies, Other Issues to document?	⦿ Yes ○ No

Two tiling schemes used, acceptable. DEMs conform to MSB_LiDAR_Imagery_Tiles.shp while classified las files and intensity files conform to MSB_LiDAR_Imagery_Quarter_Tiles.shp.

Project Geographic Information

Areal Extent:

3134

Sq Mi

Grid Size:

1

meters

Tile Size:

varies

 U.S. feet

Nominal Pulse Spacing:

1

 meters

Vertical Datum: NAVD88 U.S. feet

Horizontal Datum: NAD83 U.S. feet

Project Projection/Coordinate Reference System:

| NAD 1983 State Plane Alaska 4 FIPS 5004 Feet | U.S. feet.

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

- ☑ Project Shapefile/Geodatabase
- ☑ Project Tiling Scheme Shapefile/Gdb
- ☑ Checkpoints Shapefile/Geodatabase
- ☑ Project XML Metadata File
- ☑ Swath LAS XML Metadata File
- ☑ Classified LAS XML Metadata File
- ☑ Breaklines XML Metadata File
- ☑ Bare-Earth DEM XML Metadata File
- ☑ Swath LAS Files
- ☑ Classified LAS Files
- ☑ Breaklines Files
- ☑ 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:
H. Boggs

Review Start Date:
4/8/2013

Action to Contractor Date	Issue Description	Return Date
4/10/2013	Number of checkpoints stored in delivered shapefile does not match report. Delivery of checkpoint shapefile used to test and report vertical accuracy requested 4/10/13.	4/16/2013
4/24/2013	DEM and classified las file corrections requested.	5/3/2013
5/9/2013	Classified las corrections requested.	5/23/2013

Review Complete: 5/30/2013

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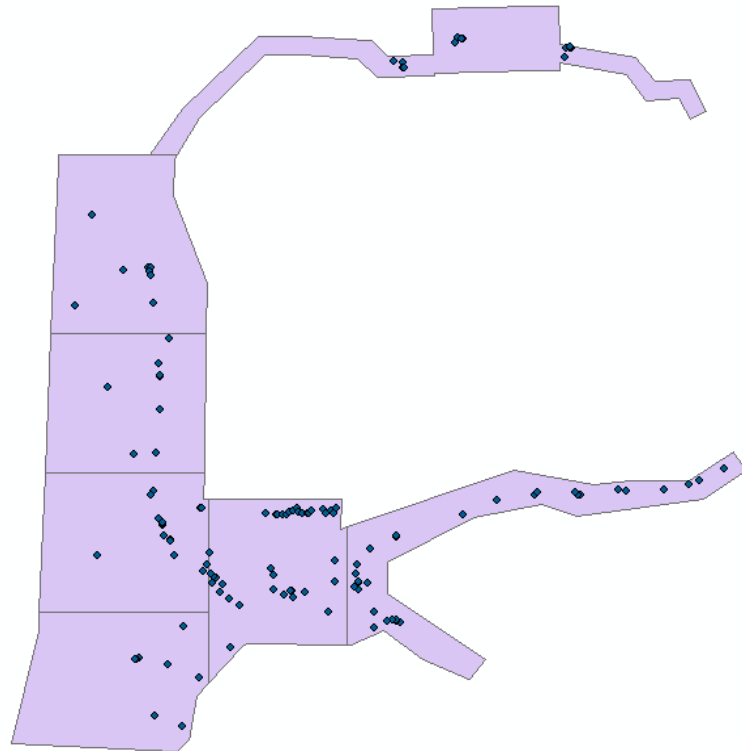
The following land cover classes are represented in this dataset (uncheck any that do not apply):

☑ 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?

Vertical accuracy testing and reporting not performed by vendor on Lot 1. The vertical accuracy of the entire project extent was tested and reported with the Lot 2 delivery.

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: centimeters

Required FVA Value is 24.5 centimeters or less.
Target SVA Value is 36.3 centimeters or less.
Required CVA Value is 36.3 centimeters or less.

The reported FVA of the LAS Swath data is 13.7 centimeters.

The reported FVA of the Bare-Earth DEM data is 18.2 centimeters.
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				N/A
Brush Lands and Low Trees		**53.3**		centimeters
Forested Areas Fully Covered by Trees		**39.9**		centimeters
Urban Areas with Dense Man-Made Structu...		27.5		centimeters

The reported CVA of this data set is: 35.1 centimeters.

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 ⸢13.7⸣ ⸢centimeters⸣ .

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

Errors, Anomalies, Other Issues to document?	⊙ Yes ○ No

☐ Image?

Reviewer performed independent vertical accuracy testing on delivered swath las files and found the FVA to be 14.63cm. Acceptable.

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?

Additional classifications in this data set.
☑ 3 - Tall weeds and crops (low vegetation)
☑ 4 - Brush lands and low trees (medium vegetation)
☑ 5 - Forested areas fully covered by trees
☑ 6 - Urban area with dense man-made structures

☑ 8	-	Contour Keypoints
☑ 13	-	Noise (unclassified data 1 foot or less above ground)
☑ 14	-	Bridge Deck
☑ 18	-	May 24, 2011 data from the Matanuska Glacier withheld due to movement
☑ 19	-	May 31, 2011 data from the Matanuska Glacier withheld due to movement
☑ 26	-	May 13, 2011 data from the Knik Glacier withheld due to movement
☑ 27	-	May 24, 2011 data from the Knik Glacier withheld due to movement
☑ 28	-	August 26, 2011 data from the Knik Glacier withheld due to movement

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

Errors, Anomalies, Other Issues to document? ◉ Yes ○ No

☐ Image?

Many delivered classified las tiles do not contain projection information in their headers. This information is required, corrections requested 4/24/13. Corrections received at NGTOC on 5/3/13, however, 1,064 out of 1,520 delivered classified las tiles still do not contain projection information in their headers. Additional corrections requested 5/9/13. Additional corrections received at the NGTOC on 5/23/13 and accepted on 5/30/13.

☐ Image?

Many delivered classified las tiles do not contain System ID information in their headers. This information is required, corrections requested. Corrections received at NGTOC on 5/3/13. Accepted 5/4/13.

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: tif

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 centimeters .

Reported Accuracies

Land Cover Category	# of Points	Fundamental Vertical Accuracy @95% Confidence Interval (Accuracy$_z$) 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	275	18.2		
Tall Weeds and Crops				
Brush Lands and Low Trees	54		**53.3**	
Forested Areas Fully Covered by Trees	52		**39.9**	
Urban Areas with Dense Man-Made Structures	58		27.5	
Consolidated	439			35.1

☑ QA performed Accuracy Calculations?

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Calculated Accuracies

Land Cover Category	# of Points	Fundamental Vertical Accuracy @95% Confidence Interval (Accuracy$_z$) 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	275	16.3		
Tall Weeds and Crops				
Brush Lands and Low Trees	54		**53.15**	
Forested Areas Fully Covered by Trees	52		**39.62**	
Urban Areas with Dense Man-Made Structures	58		27.43	
Consolidated	439			34.93

Based on this review, the USGS does not recommend 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.

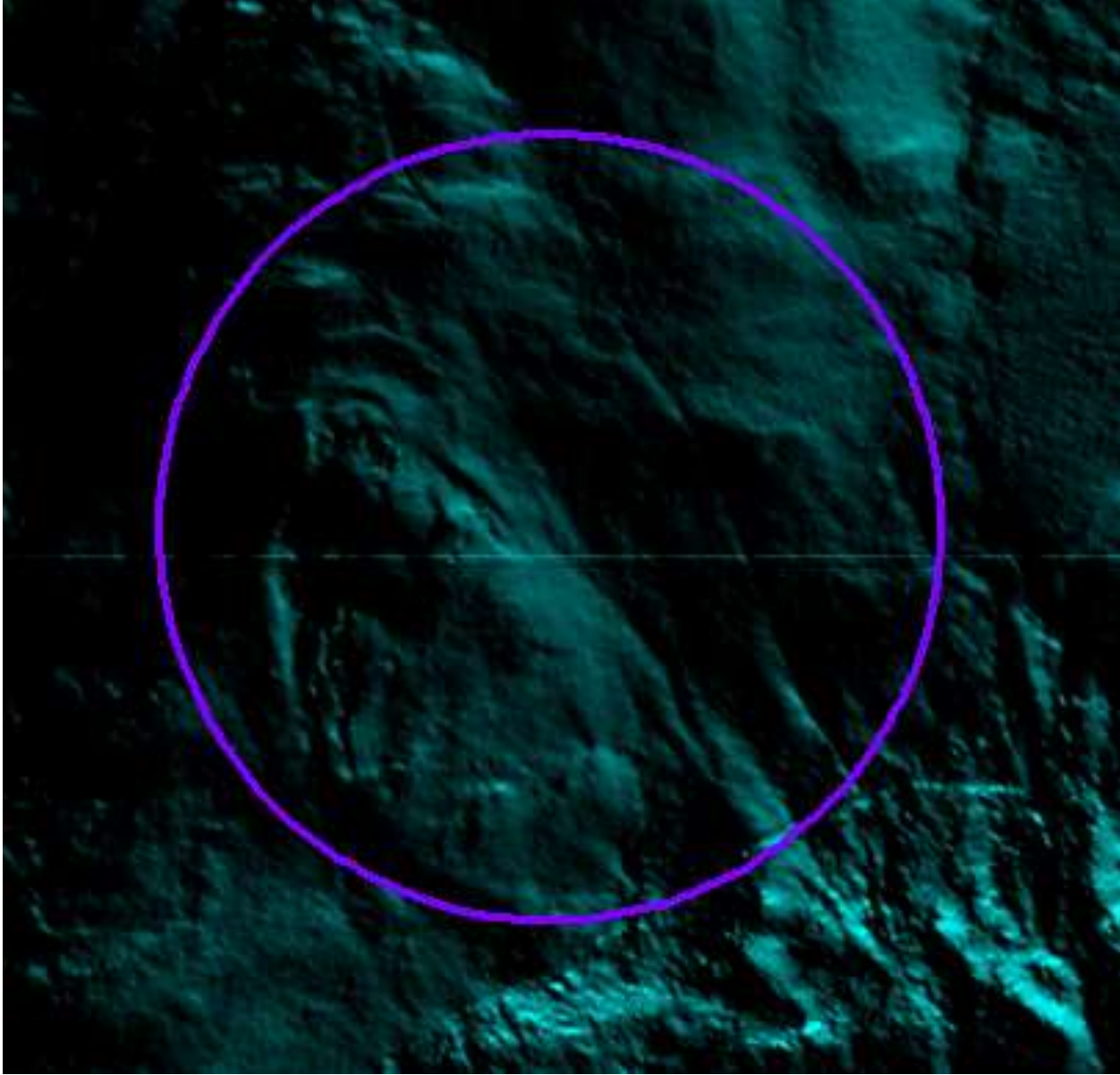Bare-Earth DEM Anomalies, Errors, Other Issues

Errors, Anomalies, Other Issues to document? ⦿ Yes ◯ No

☐ Image?

Contract with has expired, no DEM corrections will be delivered to the NGTOC. The bare earth data is being delivered to EROS as documented below.

☑ Image?

Several tiling artifacts observed throughout delivered bare-earth DEMs. Acceptable. Reviewer at NGTOC created a shapefile documenting examples of errors and/or anomalies found during review. The shapefile is named errors.shp and does not include all errors identified during review, rather, the shapefile provides at least one example of each type of error identified in the delivered bare-earth DEMs.
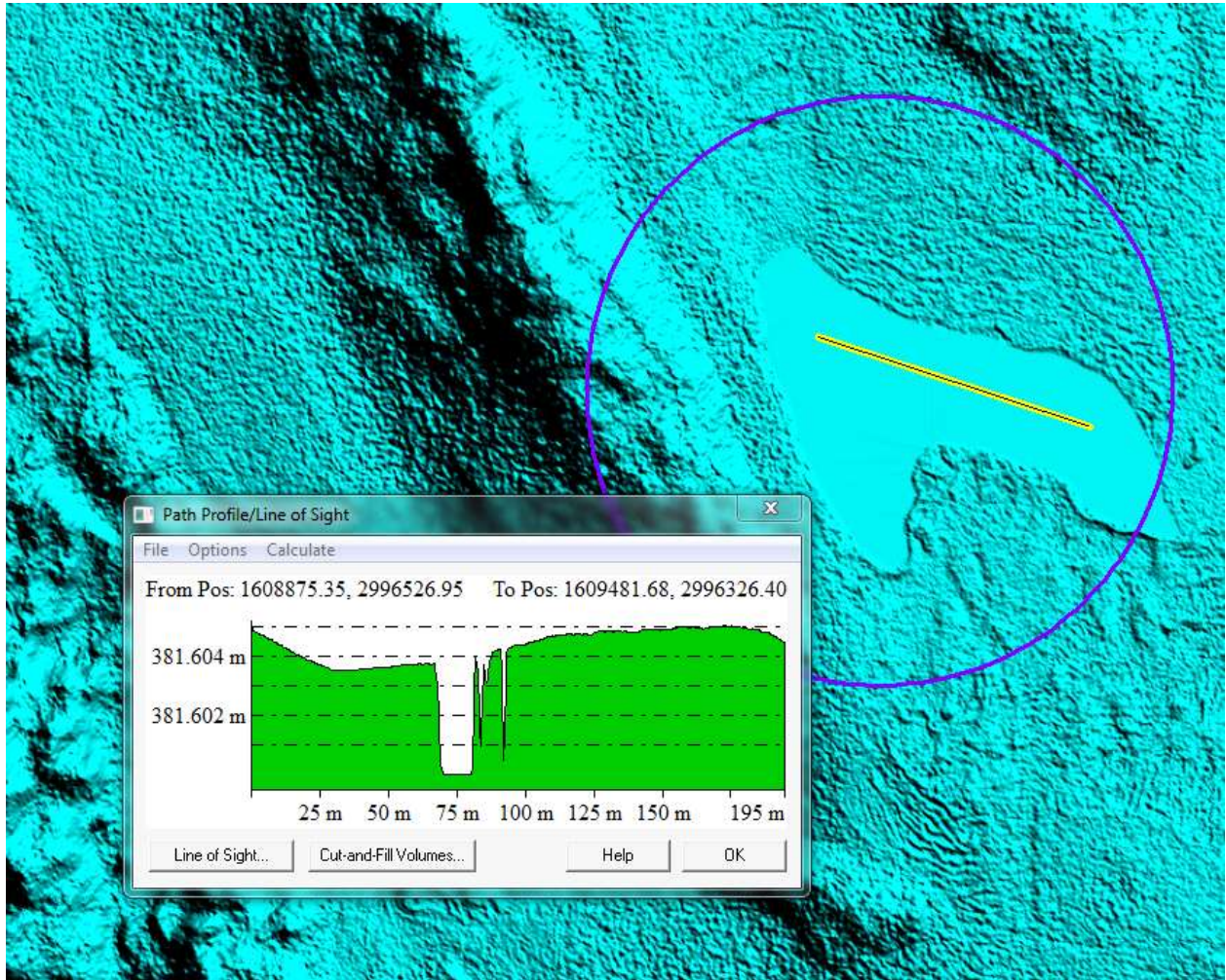
☑ Image?
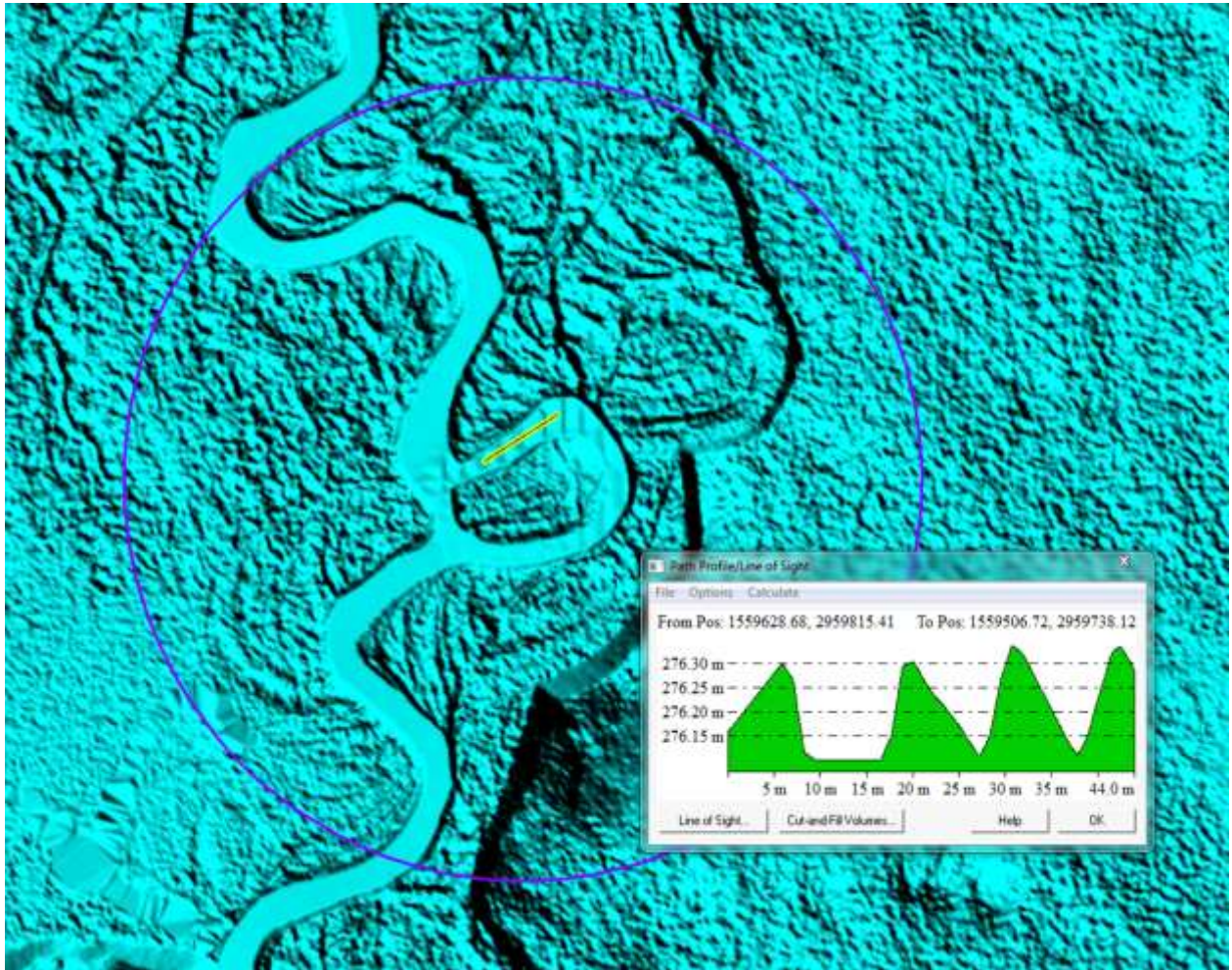
Double line stream does not maintain downstream constraint. This was observed by the reviewer throughout the delivered DEMs. Reviewer at NGTOC created a shapefile documenting examples of errors and/or anomalies found during review. The shapefile is named errors.shp and does not include all errors identified during review, rather, the shapefile provides at least one example of each type of error identified in the delivered bare-earth DEMs.
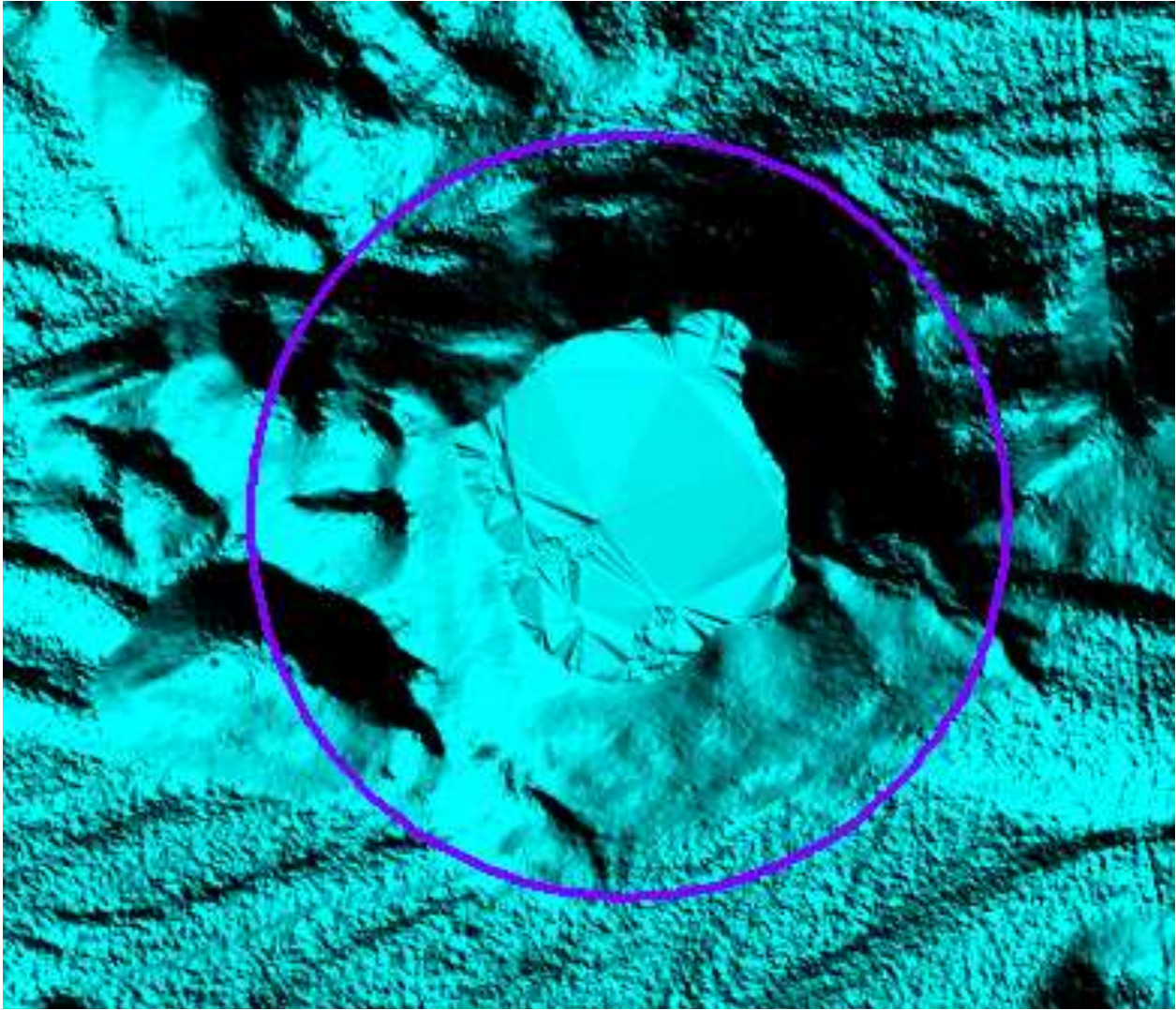
☑ Image?

Waterbody greater than 2 acres in area not correctly hydroflattened. This was observed by the reviewer throughout the delivered DEMs. Reviewer at NGTOC created a shapefile documenting examples of errors and/or anomalies found during review. The shapefile is named errors.shp and does not include all errors identified during review, rather, the shapefile provides at least one example of each type of error identified in the delivered bare-earth DEMs.

☑ Image?

Waterbody greater than 2 acres in area not hydroflattened. No breaklines associated with waterbody. This was observed by the reviewer throughout the delivered DEMs. Reviewer at NGTOC created a shapefile documenting examples of errors and/or anomalies found during review. The shapefile is named errors.shp and does not include all errors identified during review, rather, the shapefile provides at least one example of each type of error identified in the delivered bare-earth DEMs.
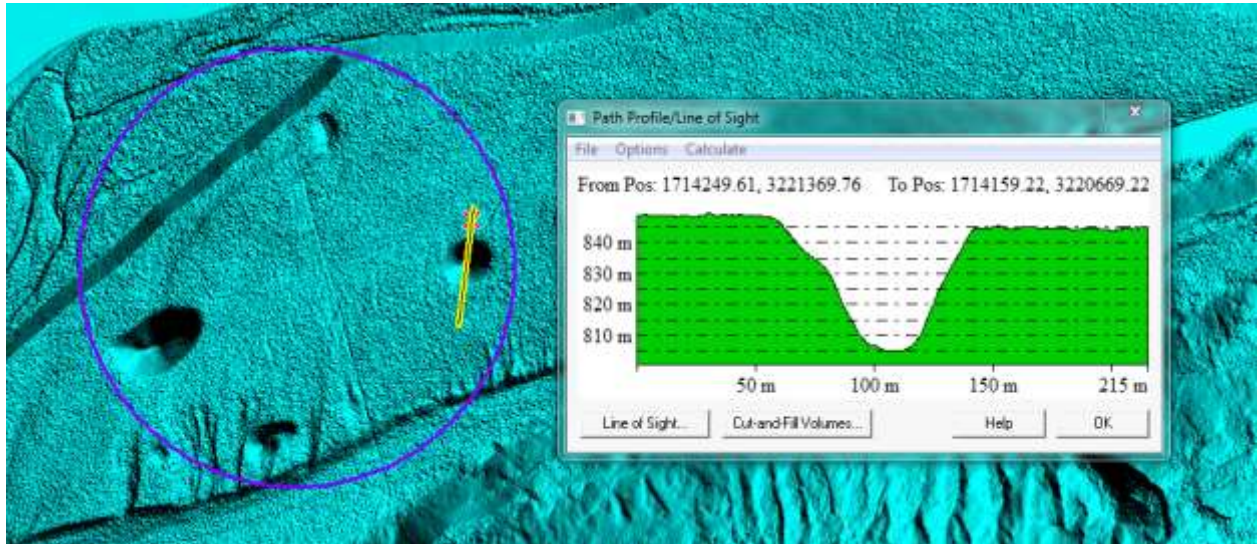
☑ Image?
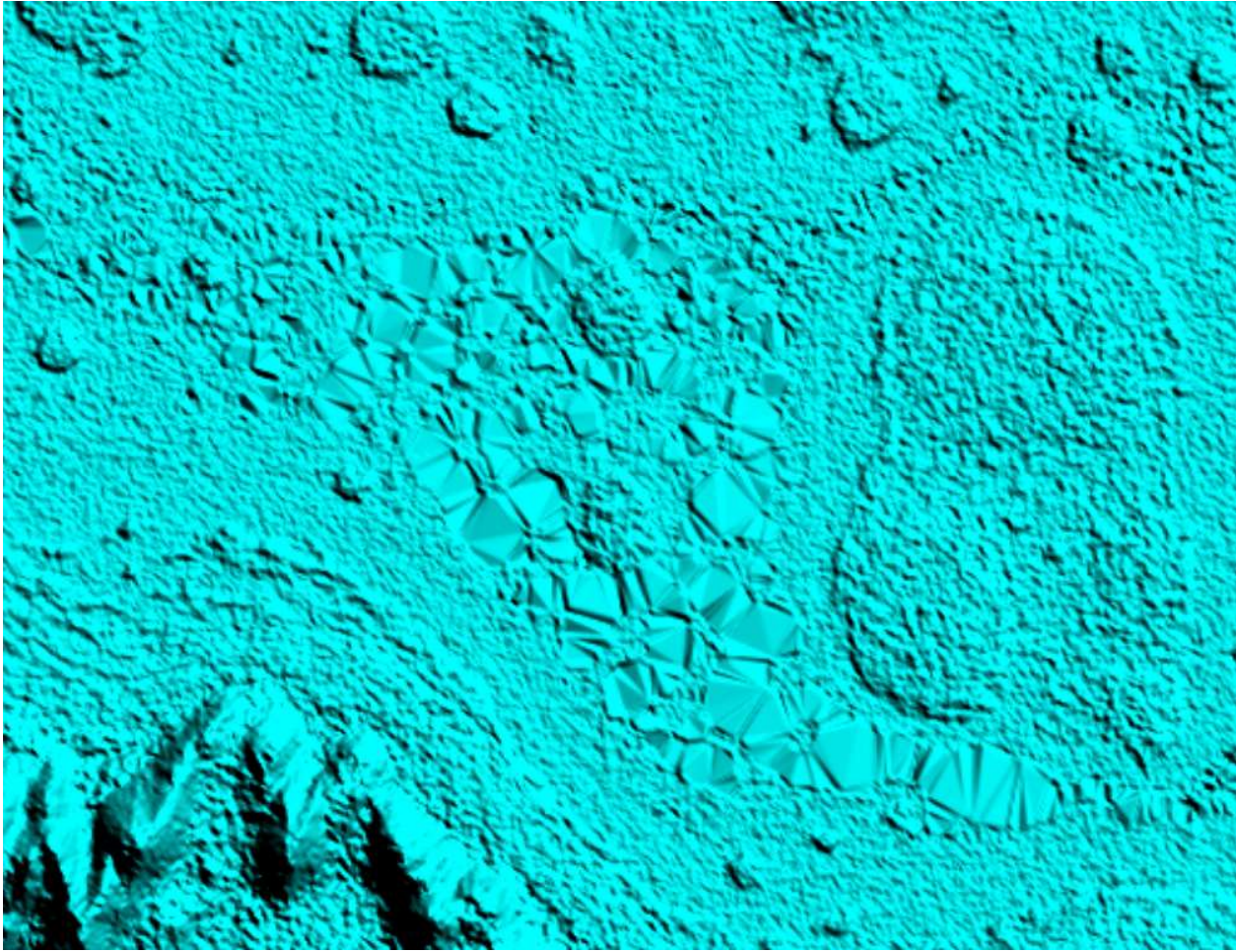
Extreme tinning observed throughout the bare-earth surface. Reviewer at NGTOC created a shapefile documenting examples of errors and/or anomalies found during review. The shapefile is named errors.shp and does not include all errors identified during review, rather, the shapefile provides at least one example of each type of error identified in the delivered bare-earth DEMs.

☑ Image?

Pits in bare earth surface. Reviewer at NGTOC created a shapefile documenting examples of errors and/or anomalies found during review. The shapefile is named errors.shp and does not include all errors identified during review, rather, the shapefile provides at least one example of each type of error identified in the delivered bare-earth DEMs.

Internal Note:

<u>This is the end of the report.</u>

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