![USGS science for a changing world]

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. 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.

MS_Washington-Choctaw_2014

NGTOC
2015-04-17
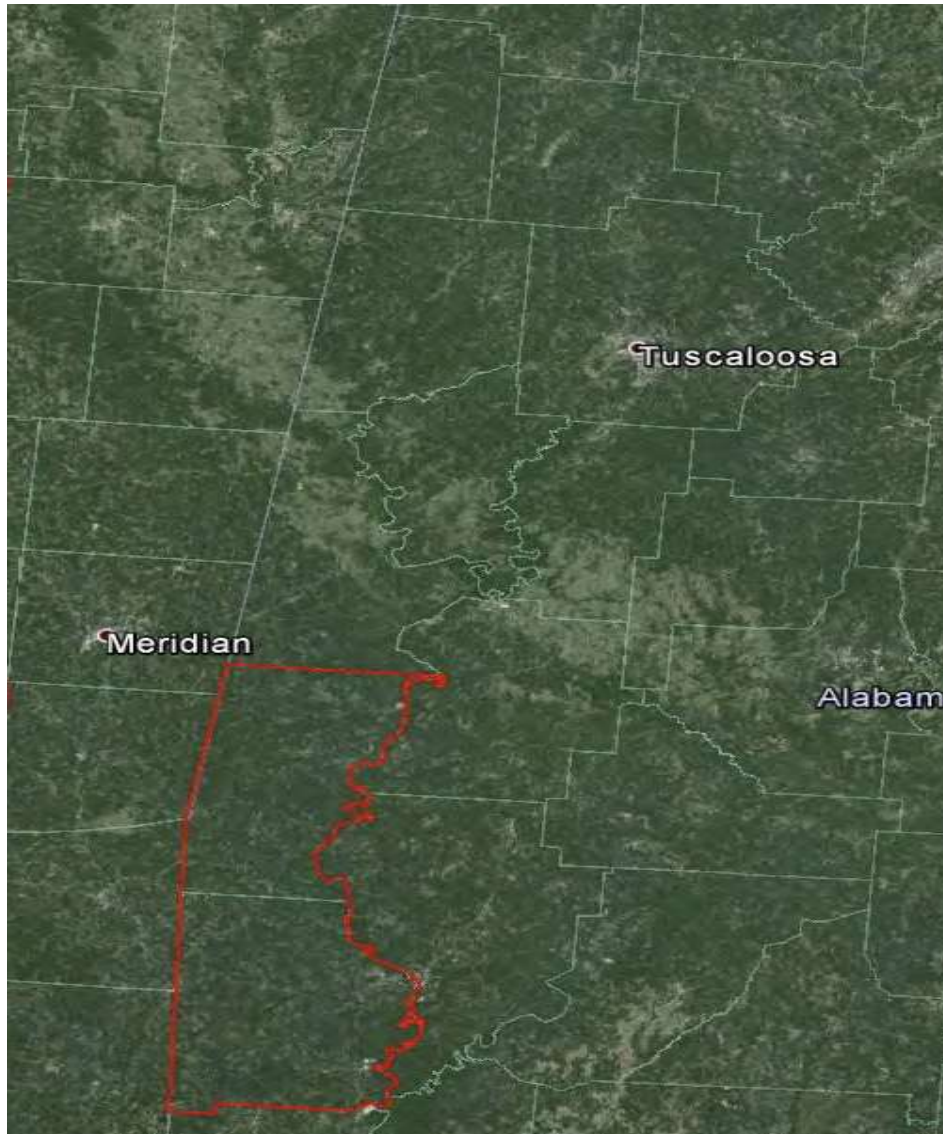
Project Information

Project:

MS_Washington-Choctaw_2014

Contractor:

Woolpert, Inc.

Project Type: *Applicable Specification:*

GPSC   NGP LiDAR Base Specification V 1.0

Project Points of Contact:

Name:	Type:	Email:
Jeremiah R. Vinyard-Houx	CPT	jvinyard-houx@usgs.gov

REPORT QUALIFICATION SUMMARY:

Project Delivery Lots: None

Task Order Overall:
Meets Requirements

Metadata:
  1 of 1   Reviews Accepted
  0 Reviews Not Accepted

Vertical Accuracy:
  1 of 1   Reviews Accepted
  0 Reviews Not Accepted

Swath/Raw LAS:
  1 of 1   Reviews Accepted
  0 Reviews Not Accepted

Tiled/Classified LAS:
  1 of 1   Reviews Accepted
  0 Reviews Not Accepted

Breakline:
  1 of 1   Reviews Accepted
  0 Reviews Not Accepted

DEM(s):
  1 of 1   Reviews Accepted
  0 Reviews Not Accepted

NED Review:
  1 of 1   DEM tile reviews recommended for NED 1/3rd
  1 of 1   DEM tile reviews recommended for NED 1/9th

Dates Collected Range:

Collection Start: 1/7/2014

Collection End: 2/15/2015

Project Aliases:

NRCS Laurel MS 0,7 NPS LIDAR, TO#:G13PDO1086

Licensing:

Public Domain

Project Description:

This task order requires lidar data to be acquired in two separate AOI's over 10 counties in Mississippi; Attala, Leake, Lexington, Montgomery, Scott, Smith, Webster Counties and a portion of Carroll, Choctaw and Jasper Counties and two counties in Alabama; Washington and Choctaw. The combined area of both AOI's is approximately 7,400 square miles. The lidar was collected and processed to meet a maximum Nominal Post Spacing (NPS) of 0.7 meters.

Review Information

3rd Party QA Performed: ☐   *Date Delivered:* 12/23/2014

Action To Contractor Date:	Issue Description:	Return Date:
2/11/2015	1- Floating water issues 2- Missing checkpoints	3/13/2015
3/13/2015	1- Unexplained existence of overlapping Swath LAS file (Tile 00072_3.las) 2- Floating water errors not fixed 3- Lake 8.178 Acres not hydroflattened	4/3/2015

Review Complete:
4/17/2015

Project Materials Received

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 Section supervisor and informed of the problem. Processing will resume after the COTR has coordinated the deposition of remaining deliverables.

METADATA

Deliverables	Delivered	XML Metadata	Required	Format	Quantity	Additional Details
Collection Report:	☑		☑	*PDF*	1	Lidar Report PDF
Survey Report:	☑		☑	*Select...*	1	Survey Report PDF
Processing Report:	☑		☑	*PDF*	1	Lidar Report PDF
QA/QC Report:	☑		☑	*PDF*	1	Lidar Report PDF
Project Level XML Metadata:	☑		☑	XML	1	
Project Extent:	☑	☑	☑	*.shp*	1	
Tile Scheme:	☑	☑	☑	*.shp*	1	
Control (Calibration) Points:	☑	☐	☑	*.shp*	1	
Check (Validation)	☑	☐	☑	*.shp*	1	

| Points: | | | | | | | |

Additional Comments:	

LIDAR DATA

Deliverables	Delivered	XML Metadata	Required	Format	Quantity	Additional Details
Swath Data:	☑	☑	☑	.las	599	
Classified/ Tiled Data:	☑	☑	☑	.las	2,506	

Additional Comments:	

DERIVED DELIVERABLES

Deliverables	Delivered	XML Metadata	Required	Format	Quantity	Additional Details
DEM Tiles:	☑	☑	☑	IMG	2,506	
Breaklines:	☑	☑	☑	.shp	2	

Additional Comments:	

OTHER

Additional Deliverables	Delivered	XML Metadata	Required	Format	Quantity	Additional Details
Intensity Images	☑	☑	☑	TIFF	2,506	

Additional Comments:	

Geographic Information

Area Extent:	2033.25	Sq. Miles
Tile Size:	1500 x 1500	Meters
DEM/DTM Grid Spacing:	1	Meters

Coordinate Reference System:

UTM zone 16 N

Projection: Transverse Mercator

Horizontal Datum: <u>NAD83</u>

◉ Meters
◯ U.S. Feet
◯ Int'l Feet

Vertical Datum: <u>NAVD88</u>
GEOID12A

◉ Meters
◯ U.S. Feet
◯ Int'l Feet

THIS PROJECTION COORDINATE REFERENCE SYSTEM IS CONSISTENT ACROSS THE FOLLOWING DELIVERABLES

☑ *Project Extent*
☑ *Project Extent XML Metadata*
☑ *Project Tile Scheme*
☑ *Project Tile Scheme XML Metadata*
☑ *Control Points*
☑ *Checkpoints*
☑ *Project Level XML Metadata*

☑ *Tiled/Classified XML Metadata*
☑ *Tiled/Classified LiDAR*
☑ *Swath/Raw LiDAR XML Metadata*
☑ *Swath/Raw LiDAR*
☑ *DEM(s)*
☑ *DEM XML Metadata*
☑ *Breakline(s)*
☑ *Breakline XML Metadata*

Additional Comments:

Collection Information

Quality Level: <u>2</u>

Configured Nominal Pulse Spacing:

0.7   <u>Meters</u>

Sensor Information:

Sensor Type:
<u>Aerial Oscillating Mirror</u>
Sensor Used:
ALS70
Configured Scan Angle ± from nadir:
40   *Degrees*

Sensor Type:
<u>Aerial Oscillating Mirror</u>
Sensor Used:
Optech Gemini
Configured Scan Angle ± from nadir:
24   *Degrees*

Additional Comments:

Metadata Review Accepted

Vendor 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.
Parser can be located @ http://geo-nsdi.er.usgs.gov/validation/

The Project Level XML Metadata parsed without errors.

Check if 'Best Use' metadata for NED: ☐

The Project Extent XML Metadata parsed without errors.

Check if 'Best Use' metadata for NED: ☐

The Project Tile Scheme XML Metadata parsed without errors.

Check if 'Best Use' metadata for NED: ☐

The Swath XML Metadata parsed without errors.

Check if 'Best Use' metadata for NED: ☐

The Classified XML Metadata parsed without errors.

Check if 'Best Use' metadata for NED: ☐

The DEM XML Metadata parsed without errors.

Check if 'Best Use' metadata for NED: ☐

The Breakline XML Metadata parsed without errors.

Check if 'Best Use' metadata for NED: ☐

Additional Comments:	NOTE: Project Tile Scheme (index) and Project (Data) Extent metadata files are the same. Only the filenames are different.

Based on this review, the USGS accepts the xml metadata provided.

End of Metadata Review

Vertical Accuracy Review Accepted

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.

Required Vertical Accuracy

◉ *Yes* ○ *No*

REQUIRED FUNDAMENTAL VERTICAL ACCURACY FOR SWATH AND DEM FILES

Confidence Interval Required: 95   th % CI

Required Unit: Meters

Required # of checkpoints: 20

Required RMSEz: 0.0925

*Required Vertical Accuracy (RMSEz * .% CI)*   0.1813

REQUIRED SUPPLEMENTAL VERTICAL ACCURACY FOR DEM FILES

SVA Statistic Required: <u>*Percentile*</u>

SVA Confidence Level/Percentile Required: 95

Class	# of Checkpoints	SVA Required 95 th Percentile	
Tall Weeds & Crops	20	0.269	Meters
Brushlands & Low Trees	20	0.269	Meters
Forested Areas Fully Covered by Trees	20	0.269	Meters
Urban Areas with Dense Man Made Structures	20	0.269	Meters

REQUIRED CONSOLIDATED VERTICAL ACCURACY FOR DEM FILES

CVA Statistic Required: <u>*Percentile*</u>

CVA Confidence Level/Percentile Required: 95

Total number of checkpoints: 100

Required CVA: 0.269   Meters   at the 95 th Percentile

Additional Required Vertical Accuracy Information:

Reported Vertical Accuracy

◉ *Yes* ○ *No*

REPORTED FUNDAMENTAL VERTICAL ACCURACY FOR SWATH LIDAR FILES

Confidence Interval Reported: 95   th % CI

Reported Unit: Meters

Reported # of checkpoints: 50

Reported RMSEz: 0.066

*Reported Vertical Accuracy (RMSEz * .% CI)*   0.129

REPORTED FUNDAMENTAL VERTICAL ACCURACY FOR DEM FILES

Confidence Interval Reported: 95   th % CI

Reported Unit: Meters

Reported # of checkpoints: 50

Reported RMSEz: 0.07

Reported Vertical Accuracy (RMSEz * .%   0.137
CI)

REPORTED SUPPLEMENTAL VERTICAL ACCURACY FOR DEM FILES

SVA Statistic Reported: *Percentile*

SVA Confidence Level/Percentile Reported: *95*

Class	# of Checkpoints	SVA Reported 95 th Percentile	
Urban Areas with Dense Man Made Structures	50	0.180	Meters
Tall Weeds & Crops	57	0.228	Meters
Brushlands & Low Trees	48	0.261	Meters
Forested Areas Fully Covered by Trees	72	0.177	Meters

REPORTED CONSOLIDATED VERTICAL ACCURACY FOR DEM FILES

CVA Statistic Reported: *Percentile*

CVA Confidence Level/Percentile Reported: *95*

Total number of checkpoints: *277*

Reported CVA: *0.207*   *Meters*   at the *95* th Percentile

Additional Reported
Vertical Accuracy
Information:

Reviewed Vertical Accuracy

● *Yes* ○ *No*

CHECKPOINT REVIEW

Checkpoints are well distributed?   ☑

Enough checkpoints for task order?   ☑

Checkpoints meet USGS LiDAR base-spec in quantity and   ☑
quality?

REVIEWED FUNDAMENTAL VERTICAL ACCURACY FOR SWATH LIDAR FILES

Confidence Interval Reviewed: 95   th % CI

Reviewed Unit: Centimeters

Reviewed # of checkpoints:

24

Reviewed RMSEz: 7.5

*Reviewed Vertical Accuracy (RMSEz * .%
CI)* 14.7

REVIEWED FUNDAMENTAL VERTICAL ACCURACY FOR DEM FILES

Confidence Interval Reviewed: 95 th % CI

Reviewed Unit: Centimeters

Reviewed # of checkpoints: 24

Reviewed RMSEz: 7.9

*Reviewed Vertical Accuracy (RMSEz * .%
CI)* 17.0

REVIEWED SUPPLEMENTAL VERTICAL ACCURACY

SVA Statistic Reviewed: <u>*Percentile*</u>

SVA Confidence Level/Percentile Reviewed: 95

| *Class*	*# of Checkpoints*	*SVA Reviewed 95 th Percentile*	
Urban Areas with Dense Man Made Structures	24	20.10	Centimeters
Tall Weeds & Crops	24	22.0	Centimeters
Brushlands & Low Trees	23	25.4	Centimeters
Forested Areas Fully Covered by Trees	20	30.0	Centimeters

REVIEWED CONSOLIDATED VERTICAL ACCURACY

CVA Statistic Reviewed: Percentile

CVA Confidence Level/Percentile Reviewed: 95

Total number of checkpoints: 115

Reviewed CVA: 24.1   *Centimeters*   *at the* 95 th *Percentile*

Checkpoint Distribution Image
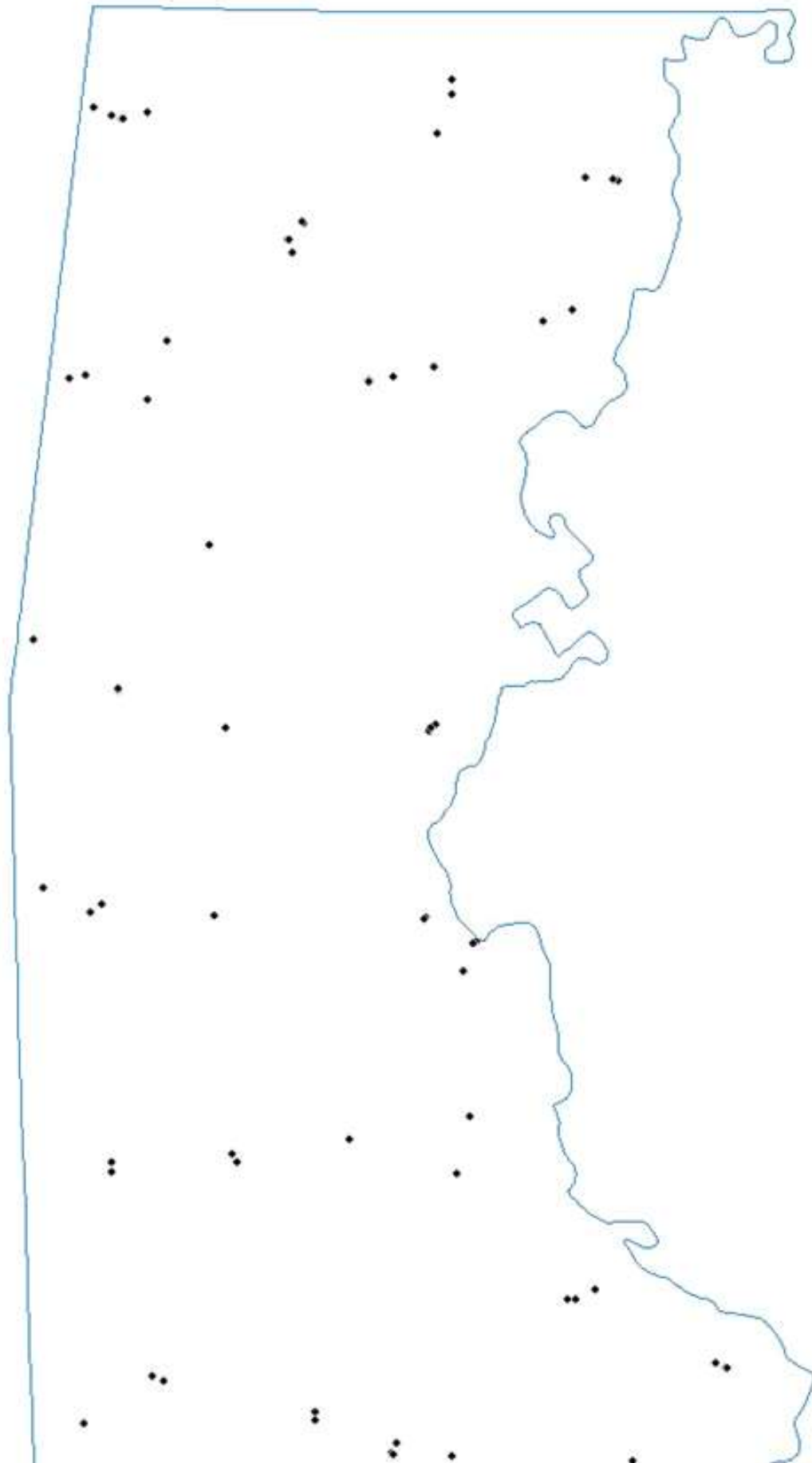
Vertical Accuracy Results:

Additional Reviewed Vertical Accuracy Information:	1- The original project (MS_Laurel_2014) divided into two separate projects (MS_Laurel_2014 & MS_Washington-Choctaw_2014) with QA Report for each. 2- Vertical accuracy processed for each project individually, which explains the discrepancy between the reviewed and reported vertical accuracy in values of FVA, SVA, CVA and numbers of check points for the classes. **3- SVA of Forested Class = 30.0, accepted based on vertical accuracy passing of FVA, CVA and SVA of MS_Laurel_2014 and the FVA, CVA and the rest of the classes of MS_Washington-Choctaw_2014.** ==Checkpoints delivered in 03-19-2015== No Check point shapefiles delivered. Also, Vertical accuracy pending DEM errors corrections

Based on this review, the USGS <u>accepts</u> the vertical accuracy.

End of Vertical Accuracy Review

Raw-Swath LiDAR Review Accepted

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 (*see Vertical Accuracy Review Section*).

Review Required: ⦿ *Yes* ○ *No*

RAW-SWATH LIDAR FILE CHARACTERISTICS

☑ *Separate folder for swath/raw LiDAR files*

LAS Version: 1.2

Point Record Format: 1

☑ *Each swath file ≤ 2 GB and properly segmented*

☑ *Correct and properly formatted georeference information is included in all LAS file headers*

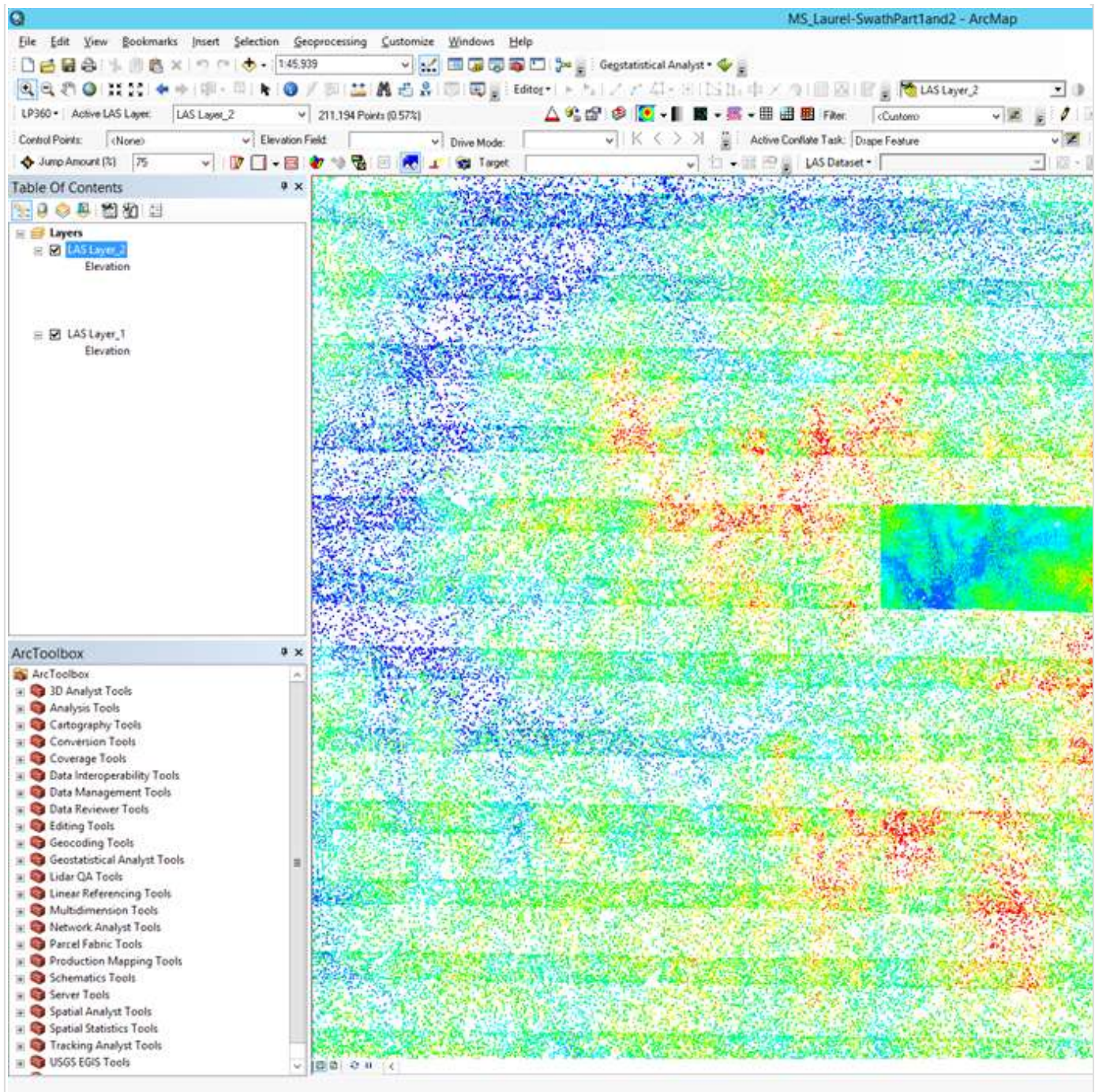☑ *Adjusted GPS time used with the global encoder id set to 1*

☑ *Scan Angles conform to USGS base-spec recommendations*

☑ *All points set to class '0' (not classified)*

Additional comments:

Additional comments:

Additional comments:

Based on this review, the USGS <u>accepts</u> the swath/raw LiDAR data.

End of Swath/Raw LiDAR Review

Tiled/Classified LiDAR Review **Accepted**

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. Classified LAS Tiles are comprised as follows, "all project swaths, returns, and collected points, fully calibrated, adjusted to ground, and classified and cut, by tiles, excluding calibration swaths, cross-ties, and other swaths not used, or intended to be used, in product generation".

Review Required: ⦿ *Yes* ○ *No*

CLASSIFIED LIDAR TILE CHARACTERISTICS

☑ *Separate folder for classified/tiled LiDAR files*

LAS Version: <u>1.2</u>

Point Record Format: <u>1</u>

☑ *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*

☑ *Correct and properly formatted georeference information is included in all LAS file headers*

☑ *Adjusted GPS time used with the global encoder id set to 1*

☑ *Classified LAS tile files have no points classified as '12' (Overlap)*

☐ *Point classifications are limited to the standard values listed below:*

Code	Description	Used
1	Processed, but unclassified	☑
2	Bare-earth/Ground	☑
7	Noise(low or high, manually identified, if needed)	☑
8	Model key points	☐
9	Water	☑
10	Ignored ground (breakline proximity)	☑
11	Withheld (if the "Withheld Bit" is not implemented in the processing software	☐

Additional Classes:

Class	Description
17	Overlap default/unclassified
18	Overlap ground

Additional comments:

Based on this review, the USGS <u>accepts</u> classified/tiled LiDAR data.

End of Tiled/Classified LiDAR Review

Breakline Review   Accepted

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

Review Required: ◉ *Yes* ○ *No*

BREAKLINE FILE CHARACTERISTICS:

☑ Separate folder for breakline files.

☑ Breaklines contain elevation values.

Elevation values stored in <u>Geometery (ZEnabled)</u>   .

Units: Meters

☑ Waterbody Breaklines.

Polyline ☐ Polygon ☑

☐ Single elevation value per waterbody feature.

☑ Required.

Waterbody Elevations were created via Unknown   waterbody level techniques.

☑ Double Line Stream Breaklines (Streams Approximately > 100 ft).

Polyline ☑ Polygon ☐

Downstream DLS Flow is <u>Stairstepped</u>   .

☑ Required.

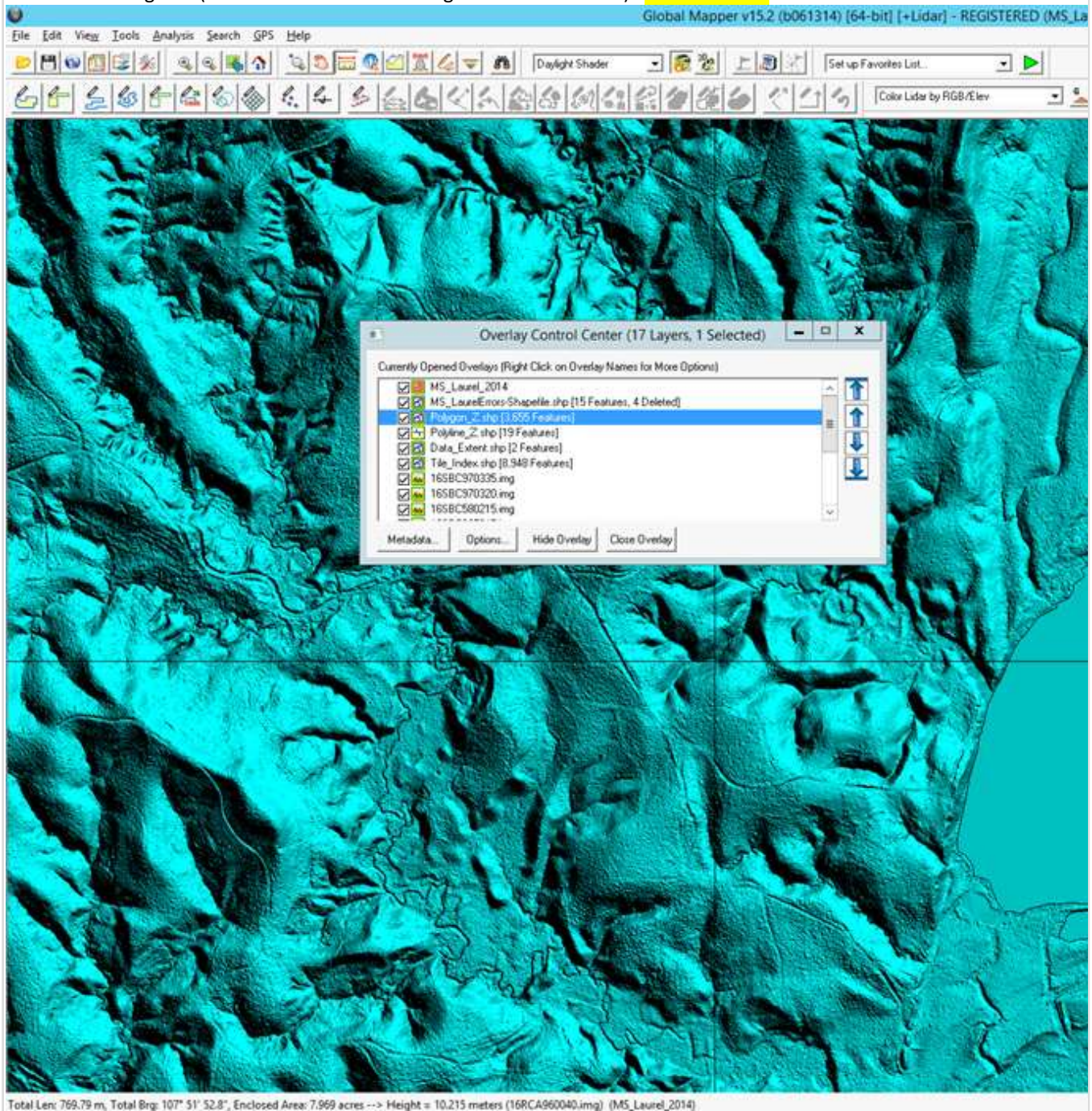☐ Single Line Breaklines.

☐ No missing or misplaced breaklines.

ADDITIONAL COMMENTS, ERRORS, ANOMALIES, OR OTHER ISSUES:

Lake accepted as swamp (shown in intensity images), based on conference call: 04-03-2015
Lake 7.969 Acres not hydroflattened
Missed flattening lake (See waterbodies 2 Acers or greater are flattened) - Error not fixed

Based on this review, the USGS <u>accepts</u> the breakline files.

End of Breakline Review

DEM Review Accepted

The derived bare-earth file(s) receive a review of the vertical accuracies provided by the data supplier, vertical accuracies calculated by the USGS using supplied and independent checkpoints (*see the prior Vertical Accuracy Review Section*), and a thorough visual review for any anomalies or inconsistencies in assessing the quality of the DEM(s).

BARE-EARTH DEM TILE CHARACTERISTICS:

☑ Separate folder for bare-earth DEM files

Raster File Type: <u>IMG</u>

Raster Cell Size: 1   <u>Meters</u>

Tile bit depth/pixel Type: 32_BIT_FLOAT

Interpolation or Resampling Technique: <u>Unknown</u>

☑ DEM tiles do not overlap
☑ DEM tiles conform to Project Tiling Scheme
☑ Quantity of DEM files conforms to Project Tiling Scheme
☑ DEM tiles are uniform in size

☑ DEM tiles properly edge match and free of edge artifacts
☑ Tiles are free from Spikes and Pits
☑ Tiles are free from Data Holidays (*voids due to processing or collection errors*)
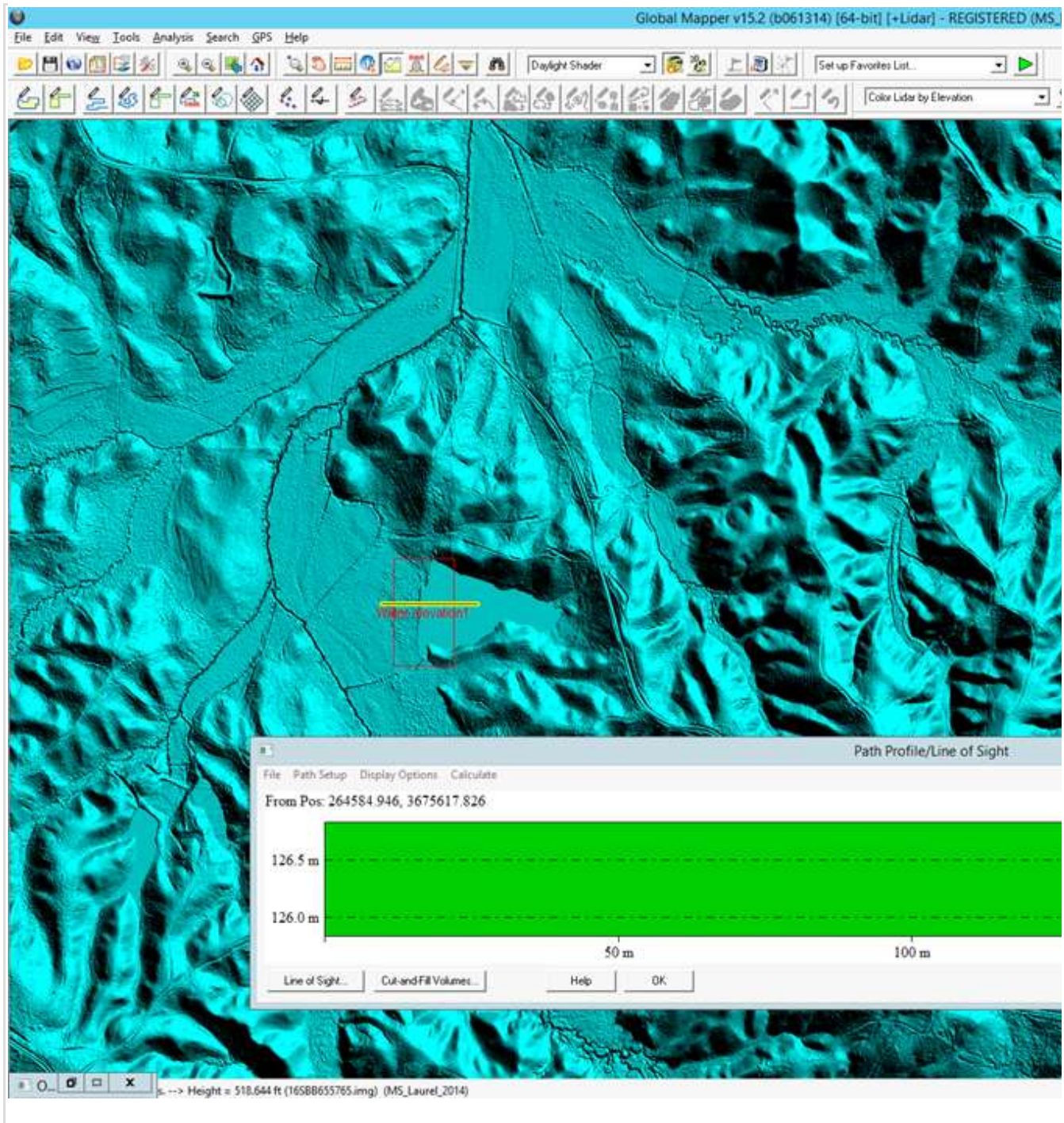☑ Tiles do not exhibit systematic sensor error or cornrowing

Hydro Treatment: <u>hydro-flattened</u>
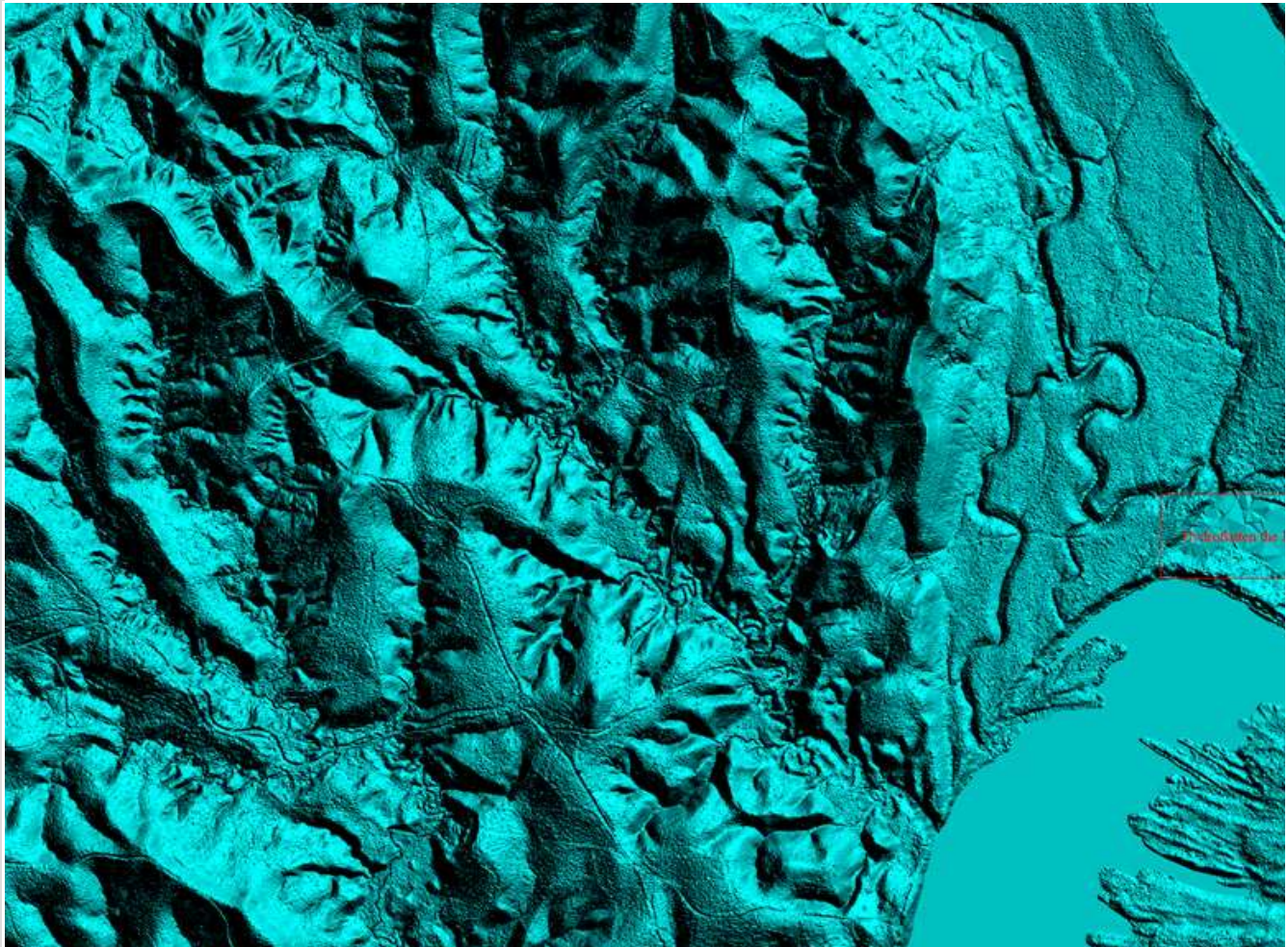
DEM tiles are properly Hydro Flattened ○ Yes ◉ No

☐ Waterbodies 2 Acres   or greater are flattened

<mark>Lake accepted as swamp as shown in intensity images (Conference call: 04-03-2015)</mark>
Errors of floating water, and missed hydroflattening of a lake

☑ Streams ⟨100 ft.⟩ or greater are flattened in a downstream manner
☑ Tidal Boundaries/Shorelines are flattened

☑ No missing islands ⟨1 Acre⟩ or larger
☑ Bridges/Overpasses are properly removed
☑ Culverts are maintained (Not Hydro Enforced)
☑ Depressions, Sinks, are not filled in (Not Hydro Conditioned)
☑ Vegetation properly removed
☑ Manmade structures properly removed

ADDITIONAL COMMENTS, ERRORS, ANOMALIES, OR OTHER ISSUES:

1- Presence of dense vegetation; this is OK
2- Minimum Elevation: -340282346638528860000000000000000000000000.000 m (buffer zone?) Error Fixed (03-19-2015)

Tiles recommended for NED 1/3rd: ⦿ Yes. ○ No.
Tiles recommended for NED 1/9th: ⦿ Yes. ○ No.
Tiles recommended for NED 1 Meter: ⦿ Yes. ○ No.
LAS dataset recommended for distribution: tile classified

Based on this review, the USGS <u>accepts</u> the DEM tiles.

End of DEM Review

> Based on this review, the provided delivery <u>Meets</u> the Contract and/or Task Order requirements.
> *Additional Comments:*

END OF REPORT (v2.3.0)