



LiDAR Quality Assessment Report

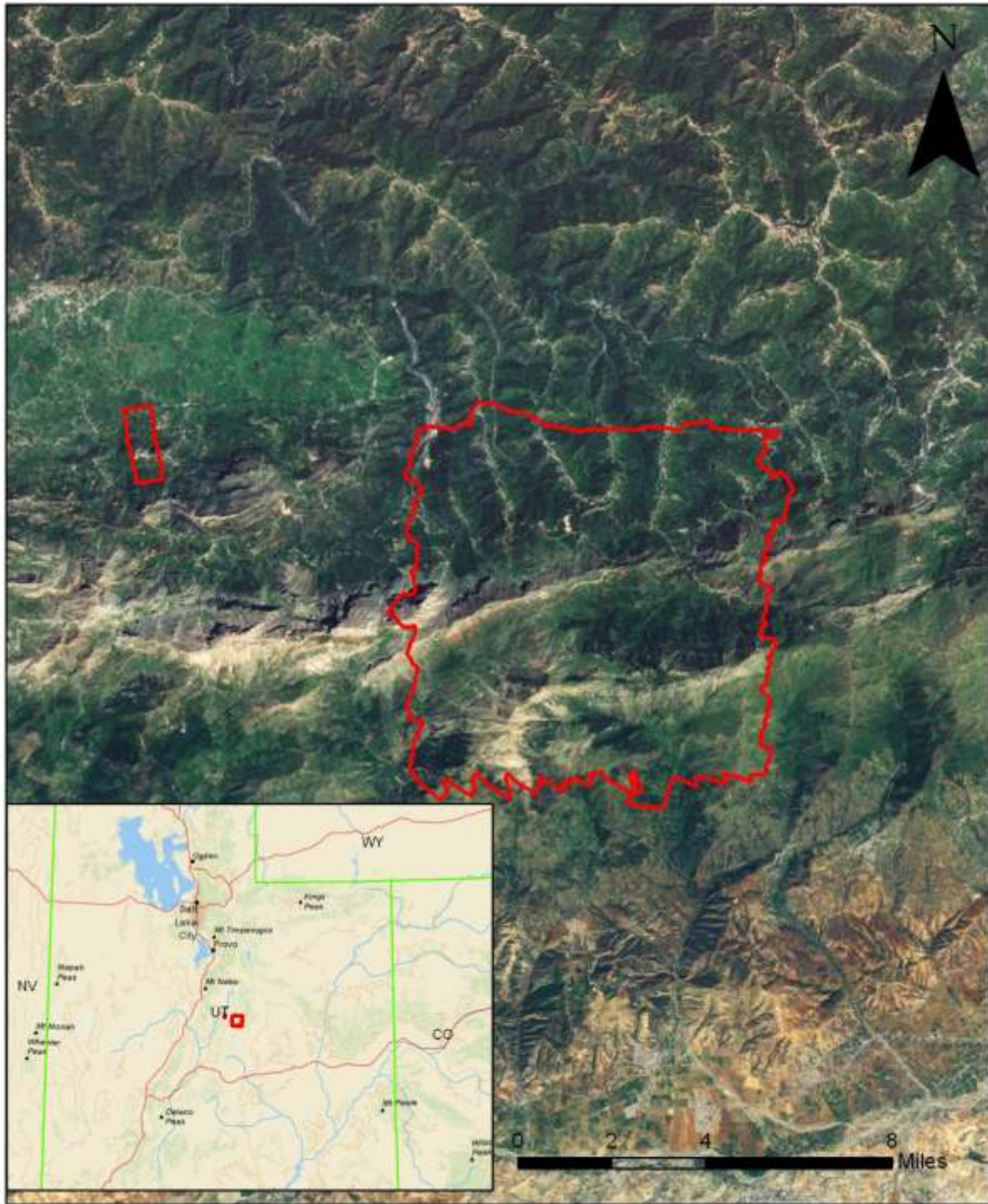
The USGS National Geospatial Technical Operations Center, Data Operations Branch is responsible for conducting reviews of all Light Detection and Ranging (LiDAR) point-cloud data and derived products delivered by a data supplier before it is approved for inclusion in the National Elevation Dataset and 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: 3/2/2012	Project Type: Donated Data
Project ID: UT_Lowry-Water_2011	Project Description: Pilot Data for UT_Lowry-Water_2011
Project Alias(es): Lowry	Year of Collection: 2011

Lot 1 of 2 lots.

Project Extent:
 Project Extent image?

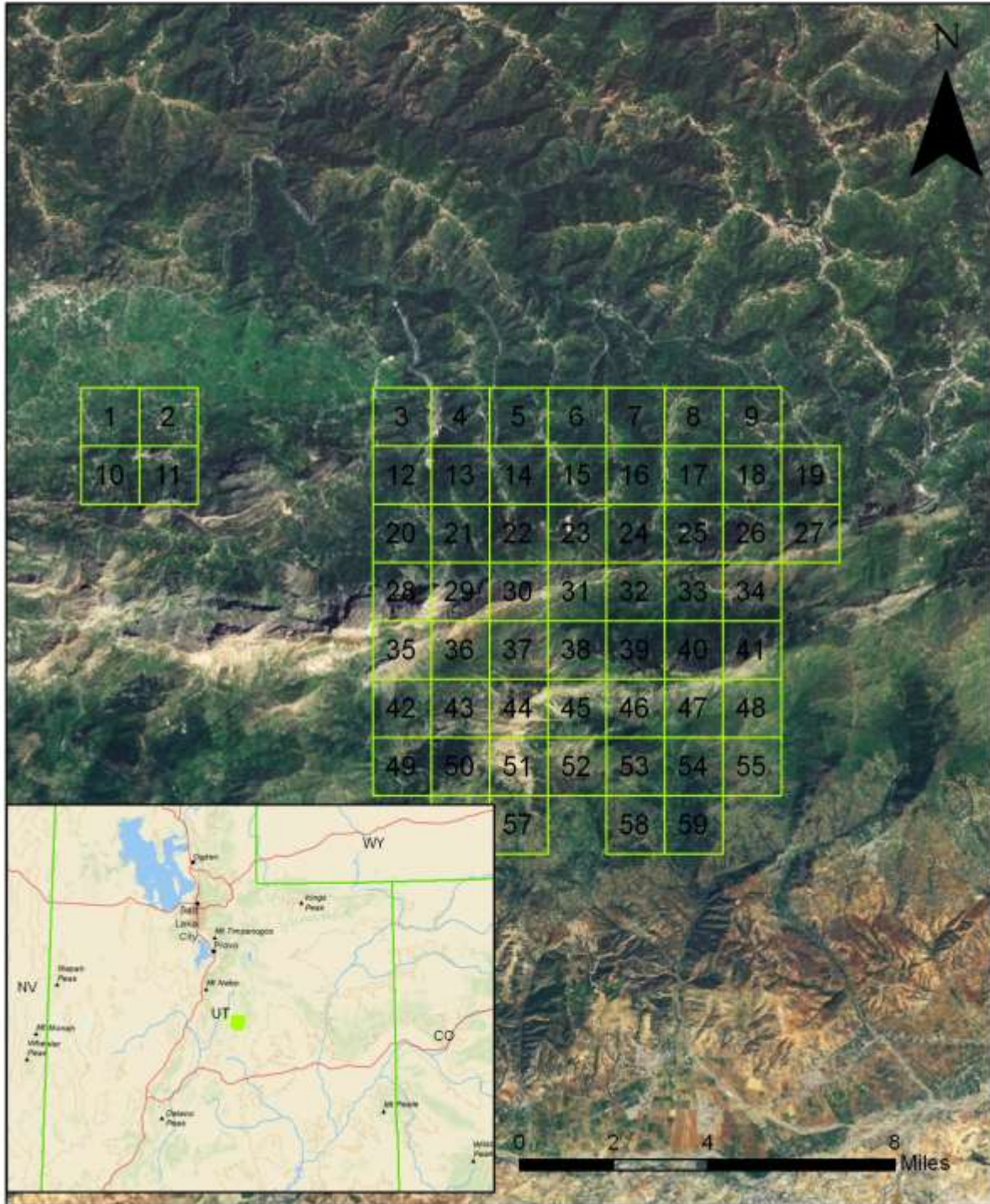
UT_Lowry-Water_2011_Pilot



Project Tiling Scheme:

Project Tiling Scheme image?

UT_Lowry-Water_2011_Pilot



Contractor: _____

Applicable Specification: _____

Select or type...Utah State University L... | V13

Licensing Restrictions:

[Empty text box for Licensing Restrictions]

Third Party Performed QA?

Project Points of Contact :

POC Name	Type	Primary Phone	E-Mail
Dave Vincent	NSDI Liaison		

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	38
<input type="checkbox"/> Intensity Image Files	↓
<input checked="" type="checkbox"/> Tiled LAS Files	59
<input type="checkbox"/> Breakline Files	↓
<input checked="" type="checkbox"/> Bare-Earth DEM Files	59

Additional Deliverables

	Item
<input checked="" type="checkbox"/>	DSM Tiles (59)
<input checked="" type="checkbox"/>	Project Boundary File for Complete Areas (not pilot areas included).

Errors, Anomalies, Other Issues to document? Yes No

|

Project Geographic Information

Areal Extent: 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 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 type="checkbox"/> Project XML Metadata File | <input checked="" type="checkbox"/> Classified LAS Files |
| <input checked="" type="checkbox"/> Swath LAS XML Metadata File | <input type="checkbox"/> Breaklines Files |
| <input checked="" type="checkbox"/> Classified LAS XML Metadata File | <input checked="" type="checkbox"/> Bare-Earth DEM Files |

Not Delivered

Not Delivered

Not Delivered

Not Delivered

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.

Review Start Date:

3/6/2012

Action to Contractor Date	Issue Description	Return Date
3/12/2012	Recommended Reclassification of Points as necessary to achieve acceptable DEM's. See DEM Review Section for more details.	

Review Complete:

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 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 not able to locate independent checkpoints for this analysis. USGS does not accept at this

time the quality of the checkpoint data for these LiDAR datasets.

Errors, Anomalies, Other Issues to document? Yes No

Image?

No Check Points Provided, field survey recommended.

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
<i>Tall Weeds and Crops</i>	<input type="text" value=""/>	<input type="text" value="centimeters"/>
Brush Lands and Low Trees	<input type="text" value=""/>	<input type="text" value="centimeters"/>
Forested Areas Fully Covered by Trees	<input type="text" value=""/>	<input type="text" value="centimeters"/>
<i>Urban Areas with Dense Man-Made Structur...</i>	<input type="text" value=""/>	<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

Image?

Image?

Image?

Total Field of View for Swath Data is 60 degs. USGS V13 states that "Total FOV should not exceed 40deg (+/- 20 deg from nadir) and USGS quality assurance on collection performed using scan angles wider than 34 deg will be particularly rigorous in the edge of swath areas. It is noted that a Reigl prism sensor was used.

Image?

Points not classified to class zero, but sit on classes 2, 4, and 5.

Image?

USGS accepts all Point Cloud Data "as is" for ingestion into the CLICK, though the errors noted should be corrected wherever possible.

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

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

Errors, Anomalies, Other Issues to document? Yes No

Image?

Spatial Reference not defined in files

Image?

POINTS LOCATED ON CLASS 12! This is typically a red flag and automatic rejection for GPSC and ARRA funded USGS contracts due to the fact that many vendors use the class as overlap instead of overage. The class has been used "correctly" in this dataset; however, the USGS maintains that the best practice is to classify ALL points into the appropriate landcover class and then flag the overage points with the withheld or similar bit in the LAS file, with NO points classified on class 12.

Image?

No Points Located on class 9. Some Waterbodies were identified in the dataset. As this is donated data for the USGS, the classification of waterbodies is not required; however, the USGS prefers all waterbodies to be classified to class 9 and those approximately greater than 2 acres to be flattened in the DEMs.

Image?

USGS accepts all Point Cloud Data "as is" for ingestion into the CLICK; however it should be noted that some reclassification work will be required to create acceptable DEM's for ingestion into the NED (see DEM review section).

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 does not accept at this time the breakline files.

Errors, Anomalies, Other Issues to document? Yes No

Image for error?

No Breakline Files. Breaklines were not required in Initial Contract, though USGS would prefer all waterbodies greater than 2 acres to be leveled in DEM's, especially if DEM's are to be migrated into the 1/3 arc second NED for any donated data.

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 _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	20			
Tall Weeds and Crops				
Brush Lands and Low Trees				
Forested Areas Fully Covered by Trees				
Urban Areas with Dense Man-Made Structures				
Consolidated	20			36.3

QA performed Accuracy Calculations?

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 does not accept at this time the bare-earth DEM files.

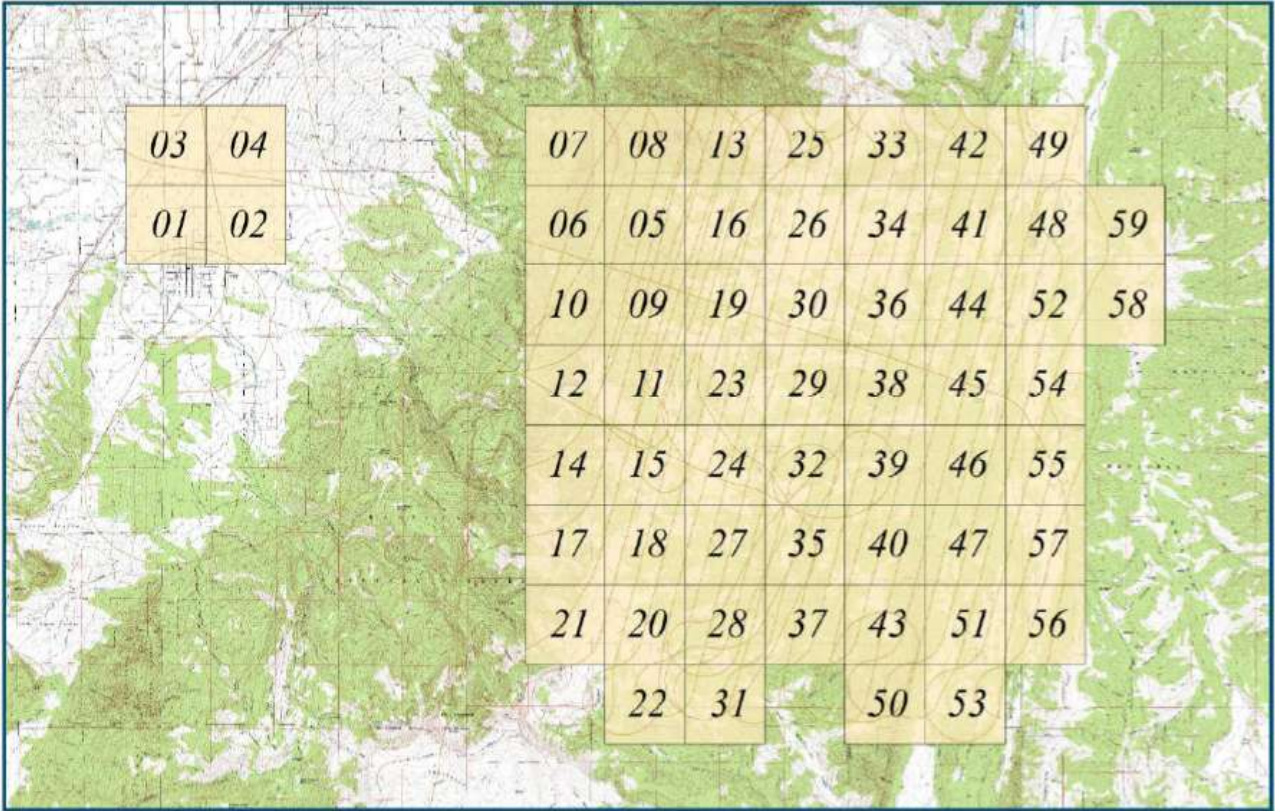
Bare-Earth DEM Anomalies, Errors, Other Issues

Errors, Anomalies, Other Issues to document? Yes No

Image?

Spatial Reference is not defined in the DEM tiles.

Image?

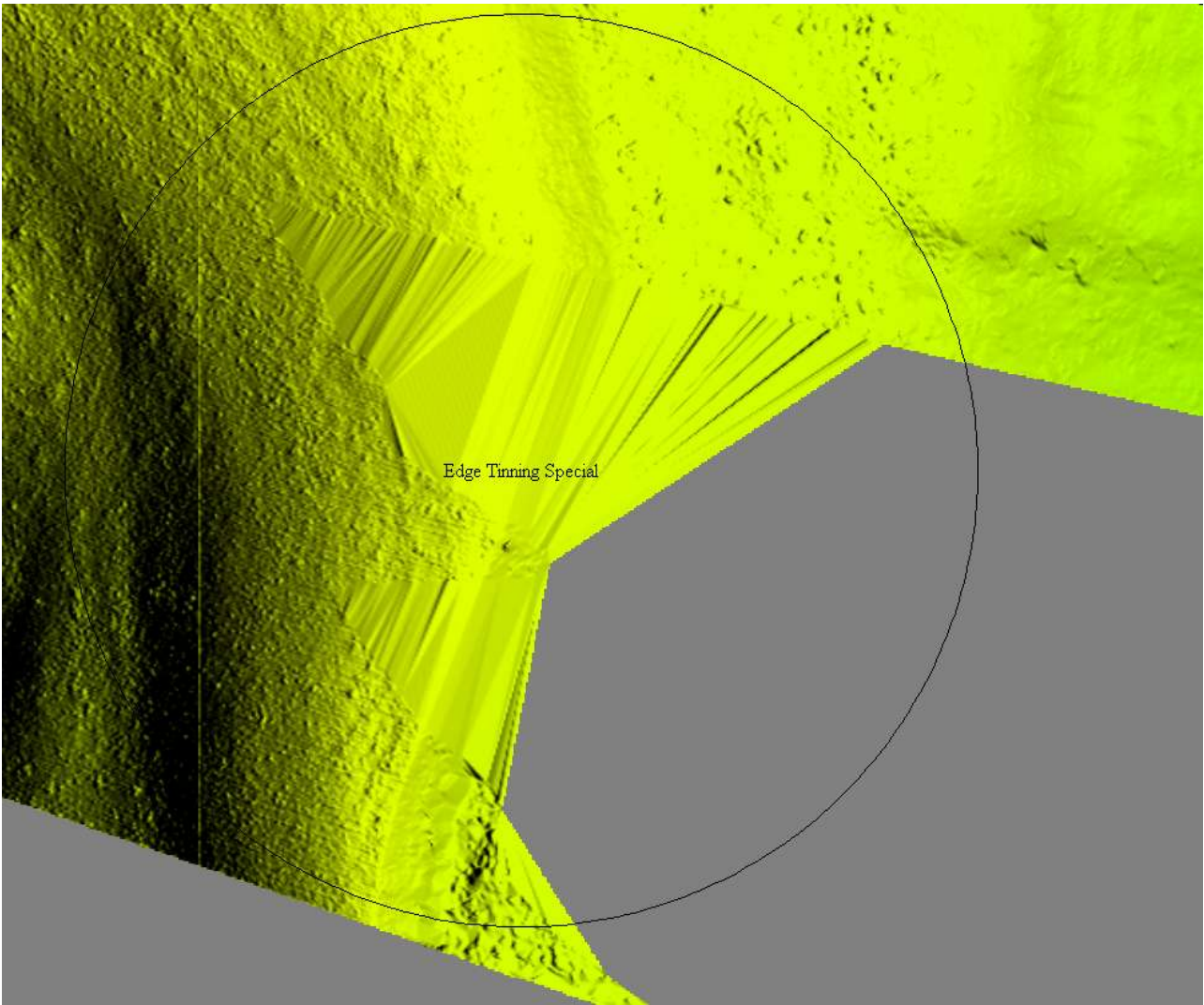


The Tiling Graphic in the Project Report does not match the tile shapefile or DEM layout. Moreover, the tile Layout in this graphic is random instead of following a consistent geographic layout and naming convention, fortunately the DEMs do not follow this graphic.

Image?

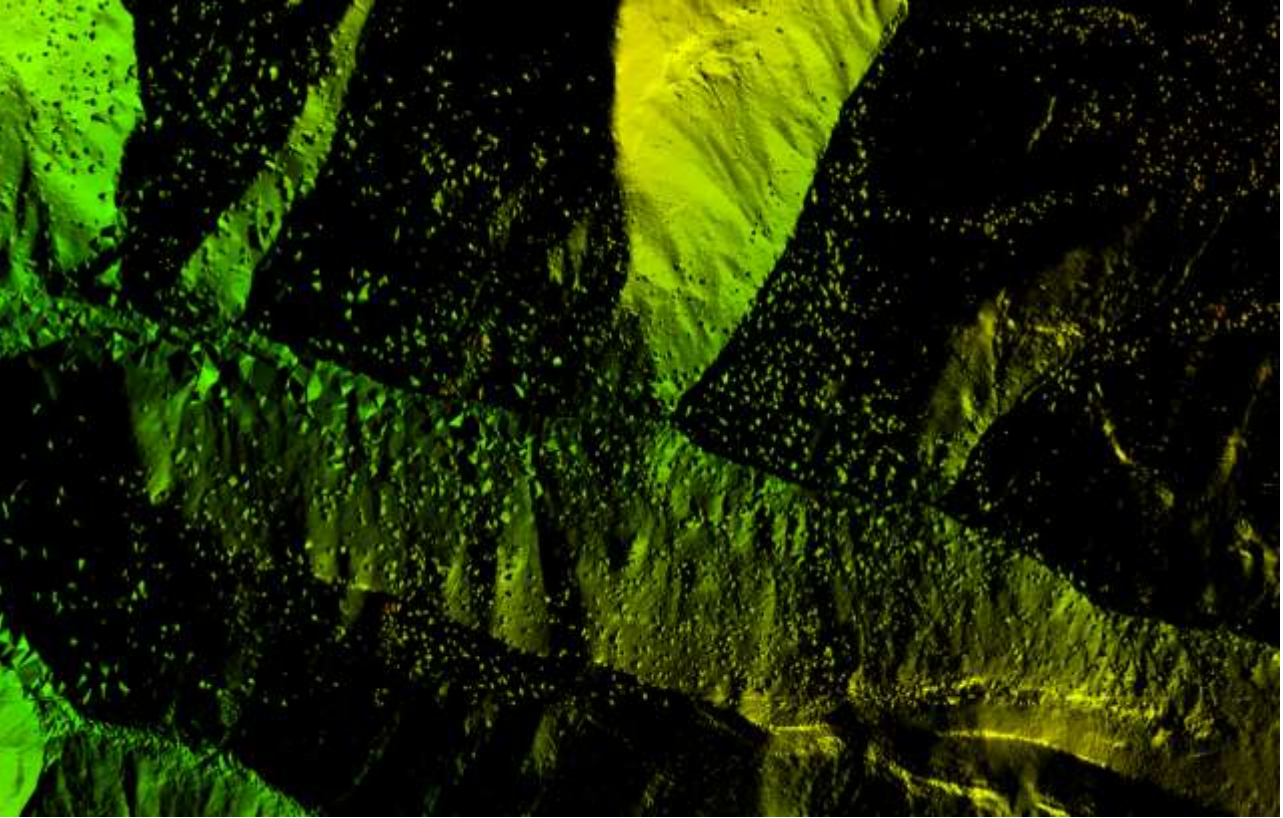
DEM Tiles are in ArcINFO ASCII Format. 32 bit floating point Erdas Imagine IMG followed by Binary ARC GRID is the USGS Preferred format(s).

Image?



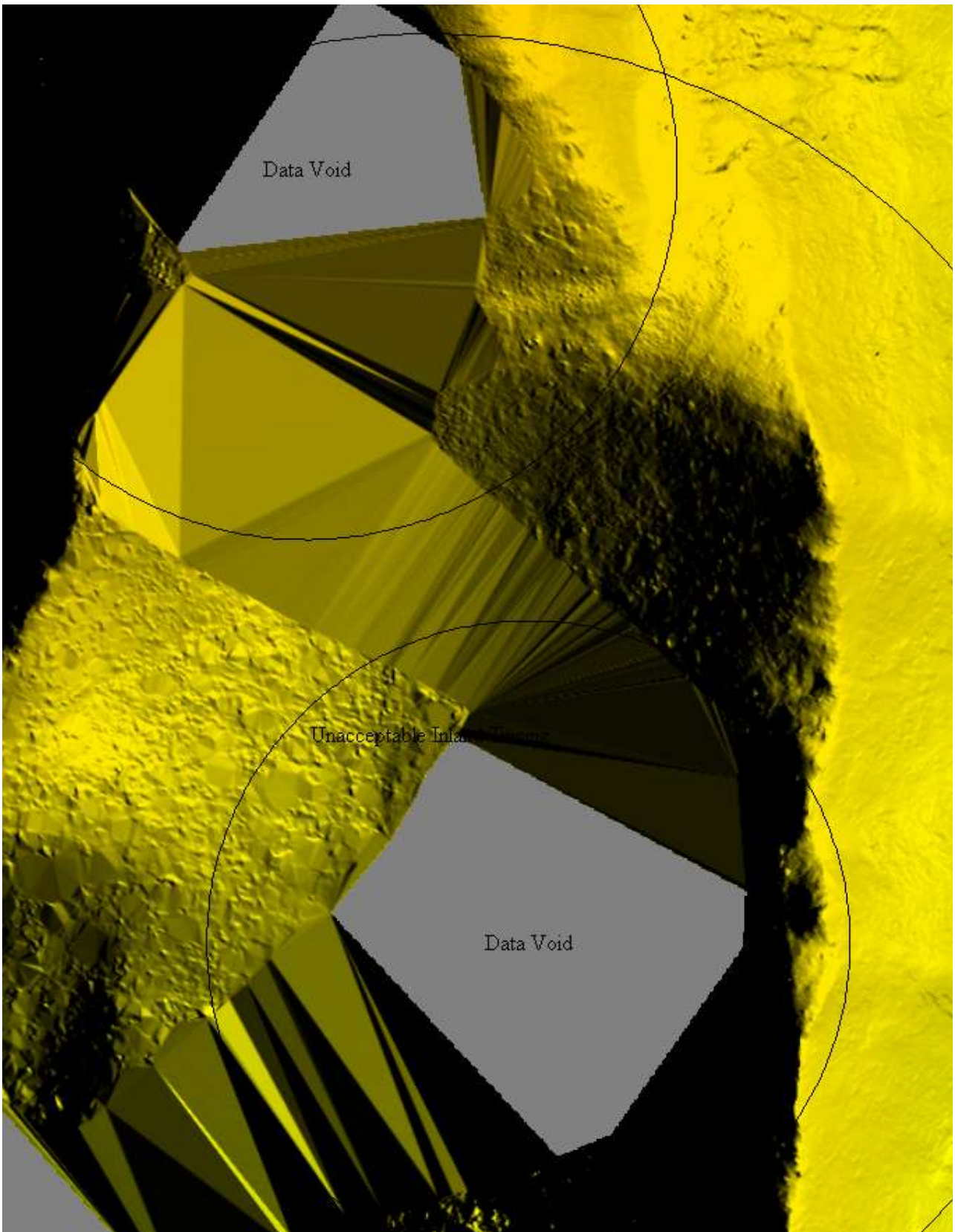
Tinning Edges Evident around concave edges of DEM tile's. These can be removed when mosaicing or by cropping with the use of a project boundary polygon. The provided project boundary polygon will remove some of these edge tinning artifacts, but not all as the boundary does not properly eliminate all areas. Areas that should be fixable are denoted as "Edge Tinning", while other areas are marked as "Edge Tinning Special" in the DEM error Tags Shapefile. USGS generated a new project boundary from the classified point cloud using only the Bare Earth points as input. This file, "Classified_Boundary.shp", is provided in the USGS Report Folder and can be used to crop out most of these tinning effects in the data, though some Tinned areas are still within the boundary; for this reason, A best practice is to fly the Lidar with a buffer in excess what the DEM's will ultimately be clipped to, making it east to delineate an interior project boundary that will likely have adequate point coverage.

Image?



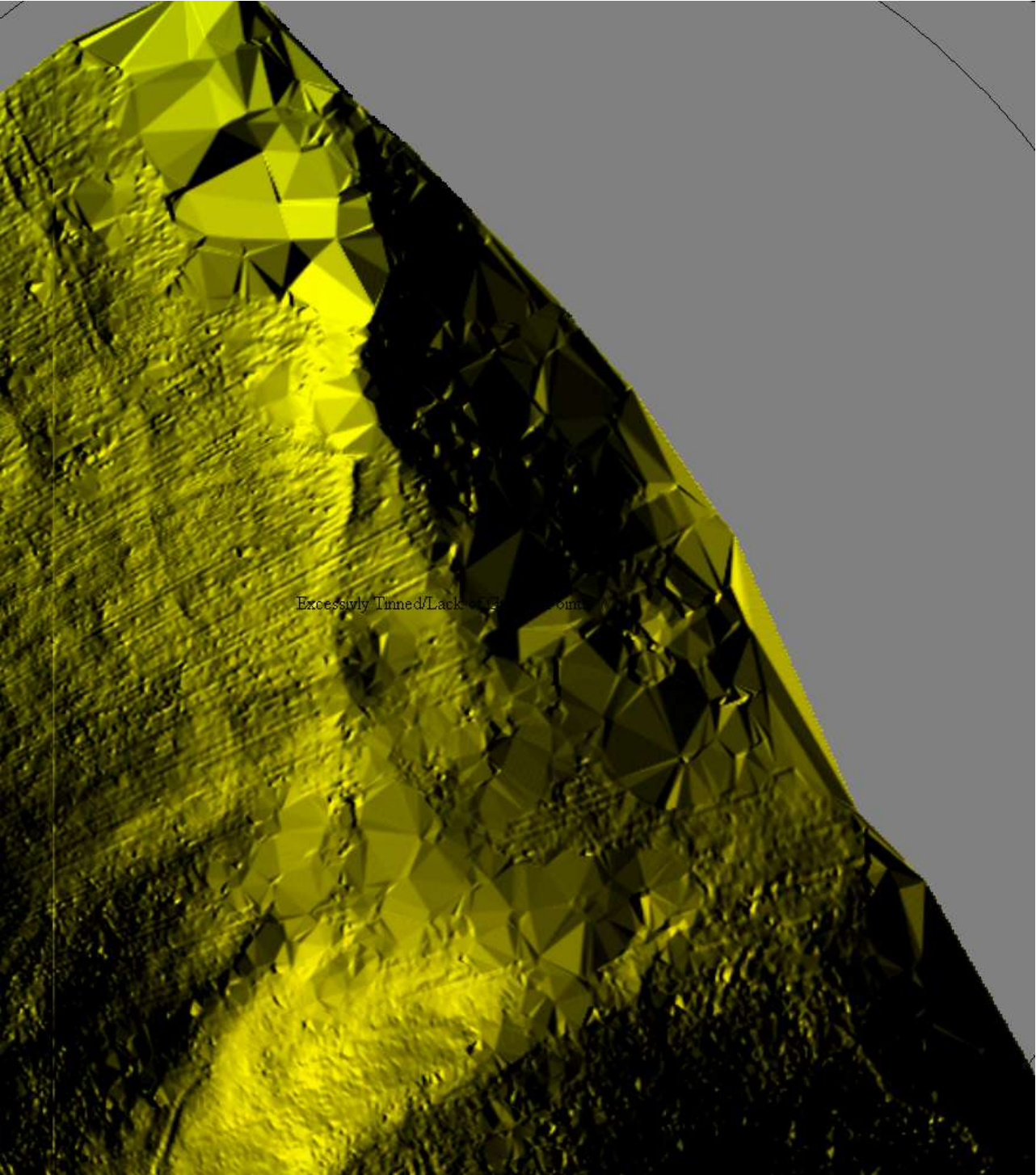
Too Much "Noise" in parts of the DEM, suggesting classification of bare earth in the point cloud was not rigorous enough, chiefly in the North West portion of the dataset. Some of the noise is grossly high. Such errors have been tagged Noise in the DEM error tags shapefile. This issue ABSOUTLY MUST BE FIXED OR THE DEMs WILL NOT BE ACCEPTED. See JPEG screen captures for more depictions of this "noise" problem.

Image?



Two Large Data Voids were Located. These appear due to Tinning where no point coverage was available. Clipping or mosaicing with appropriate project boundary would likely correct the issue. The Tinning surrounding the Data Voids is also not acceptable.

Image?



Unacceptable Inland Tinning, examination of point cloud suggest the point density is low in this area.

This is the end of the report.

QA Form V1.4 12OCT11.xsn

