



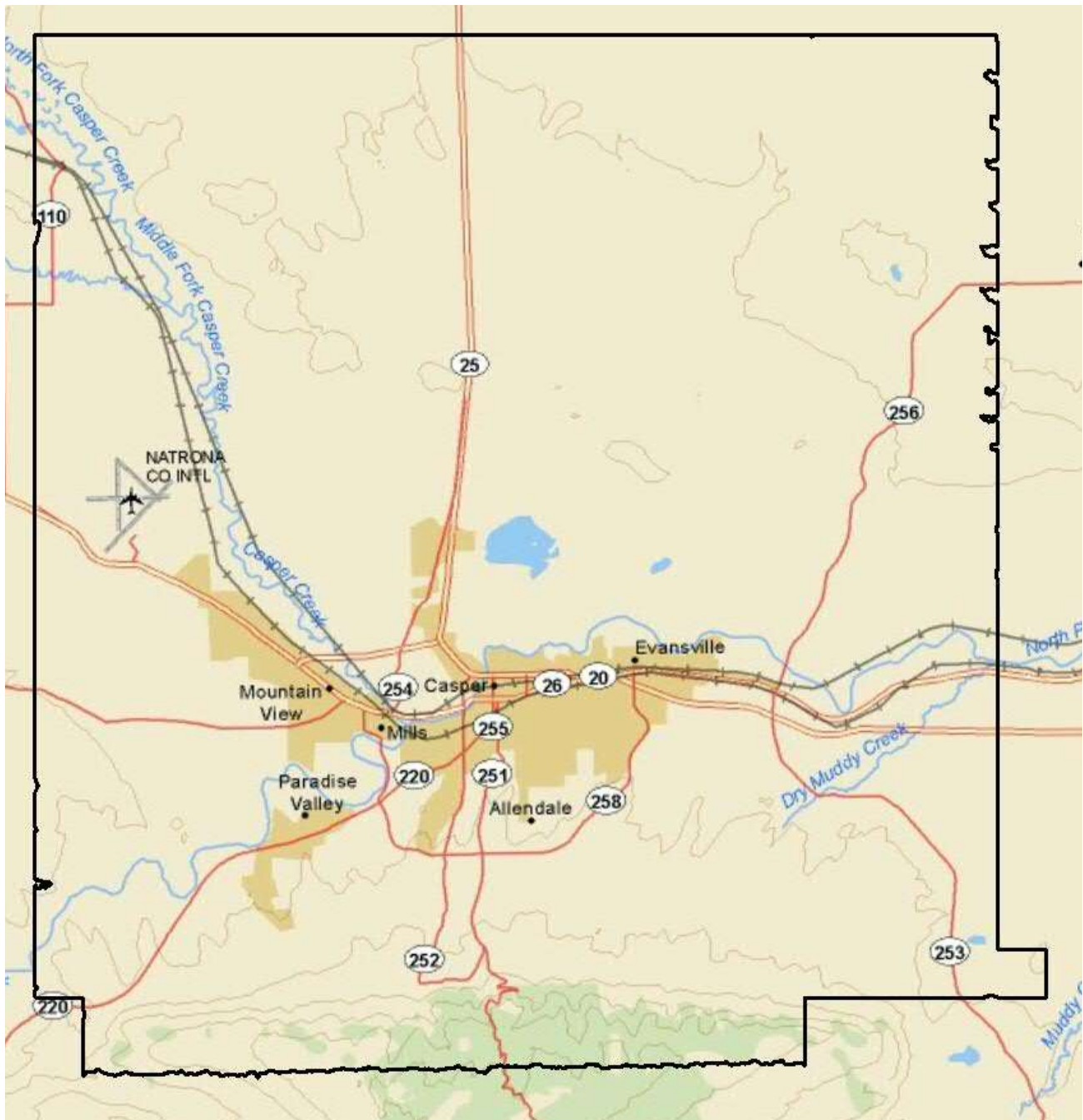
LiDAR Quality Assessment Report

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: 8/20/2011 | Project Type: Donated Data |
| Project ID: WY_Casper_2010 | Project Description: |
| Project Alias(es): | Year of Collection: 2010 |

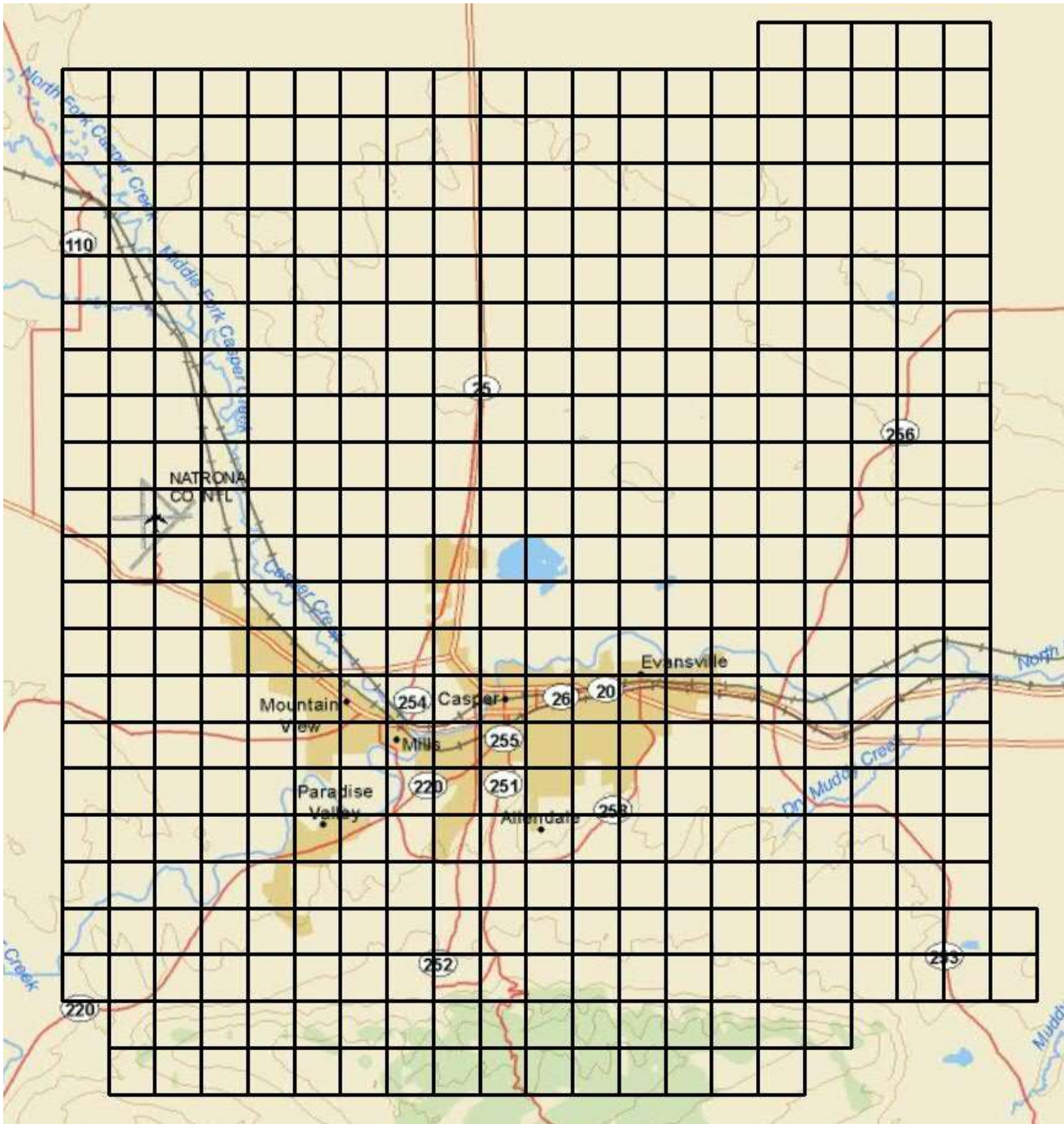
Lot 1 of 1 lots.

Project Extent:
 Project Extent image?



Project Tiling Scheme:

Project Tiling Scheme image?



Contractor:

Sanborn Map Company

Applicable Specification:

V13

Licensing Restrictions:

Ortho Imagery Included in Delivery is Currently Restricted and may be shared with NGA provided Acceptable FGDC Metadata is Provided.

Third Party Performed QA?

Project Points of Contact:

| POC Name | Type | Primary Phone | E-Mail |
|-------------|--------------|----------------|----------------|
| Barbara Ray | NSDI Liaison | (303) 236-5400 | baray@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.

- | | |
|--|---|
| <input type="checkbox"/> Collection Report <input type="checkbox"/> Survey Report <input type="checkbox"/> Processing Report <input type="checkbox"/> QA/QC Report <input type="checkbox"/> Control and Calibration Points <input type="checkbox"/> Project Shapefile/Geodatabase <input type="checkbox"/> Control Point Shapefile/Gdb | <input checked="" type="checkbox"/> Project Tiling Scheme Shapefile/Gdb <input type="checkbox"/> Breakline Shapefile/Gdb <input checked="" type="checkbox"/> Project XML Metadata <input type="checkbox"/> Swath LAS XML Metadata <input checked="" type="checkbox"/> Classified LAS XML Metadata <input type="checkbox"/> Breakline XML Metadata <input checked="" type="checkbox"/> Bare-Earth DEM XML Metadata |
|--|---|

Multi-File Deliverables

| File Type | Quantity |
|--|----------|
| <input type="checkbox"/> Swath LAS Files | |
| <input type="checkbox"/> Intensity Image Files | |
| <input checked="" type="checkbox"/> Tiled LAS Files | 510 |
| <input type="checkbox"/> Breakline Files | |
| <input checked="" type="checkbox"/> Bare-Earth DEM Files | 493 |

Additional Deliverables

| | Item |
|-------------------------------------|--|
| <input checked="" type="checkbox"/> | Ortho Photos, with currently restricted licensing (ArcGrid, MRSID) |
| <input checked="" type="checkbox"/> | Contours (DWG, SHP) |
| <input checked="" type="checkbox"/> | First Return LAS |

Errors, Anomalies, Other Issues to document? Yes No

Several preferred deliverables were not provided including the Project Footprint/AOI/Boundary. However, NGTOC was able to generate a Project Boundary based off the Classified Las Extents to use in subsequent editing and processing.

Project Geographic Information

Areal Extent: 378.928 Sq Mi

Grid Size: 2.5 U.S. Feet

Tile Size: 1500x1500 meters

2.007

6638

Nominal Pulse Spacing: 2669 U.S. feet

Vertical Datum: NAVD88 U.S. feet

Horizontal Datum: NAD83 U.S. feet

Project Projection/Coordinate Reference System: StatePlane_Wyoming_East_Central_FIPS_4902 U.S. feet.

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

- | | |
|---|--|
| <input 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 type="checkbox"/> Swath LAS Files |
| <input type="checkbox"/> Project XML Metadata File | <input checked="" type="checkbox"/> Classified LAS Files |
| <input 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 |

Project Shapefile/Geodatabase CRS

N/A

Check Point Shapefile/Geodatabase CRS

N/A

Project XML Metadata CRS

N/A

Swath LAS XML Metadata CRS

N/A

Breakline XML Metadata CRS

N/A

Swath LAS Files CRS

N/A

Breakline Files CRS

N/A

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:

9/12/2011

| Action to Contractor Date | Issue Description | Return Date |
|---------------------------|-------------------|-------------|
| | | |

Review Complete: 10/21/2011

Metadata Review

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

The Project XML Metadata file parsed with errors.

No Data to Test

The Swath LAS XML Metadata file parsed with errors.

No Data to Test

The Classified LAS XML Metadata file parsed with errors.

Did not Pass: 25 errors: 2 misplaced, 16 missing, 7 bad_value

mp 2.9.14 - Peter N. Schweitzer (U.S. Geological Survey)

Info: input file = phpUXD7Bs.xml

Info: process date = 20111021

Info: process time = 17:05:07

Warning (line 4): Unknown extension element ignored: Esri
Warning (line 4): Unknown extension element ignored: CreaDate
Warning (line 3): Discarding text found in unknown extension CreaDate
Warning (line 4): Unknown extension element ignored: CreaTime
Warning (line 3): Discarding text found in unknown extension CreaTime
Warning (line 4): Unknown extension element ignored: SyncOnce
Warning (line 3): Discarding text found in unknown extension SyncOnce
Warning (line 4): Unknown extension element ignored: DataProperties
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Warning (line 3): Discarding text found in unknown extension langdata
Warning (line 4): Unknown extension element ignored: fname
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Error (line 4): Lineage is not permitted in Metadata
Error (line 4): Process_Step is required in Lineage
Error (line 4): improper value for Beginning_Date
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Error (line 4): Distributor is required in Distribution_Information

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Error (line 4): Fees is required in Standard_Order_Process
Error (line 4): Digital_Transfer_Option is required in Digital_Form
Error (line 4): Format_Name is required in Digital_Transfer_Information
Error (line 4): improper value for Abscissa_Resolution
Error (line 4): improper value for Ordinate_Resolution
Error (line 4): improper value for Grid_Coordinate_System_Name
Error (line 4): Entity_Type_Label is required in Entity_Type
Error (line 4): Entity_Type_Definition is required in Entity_Type
Error (line 4): Entity_Type_Definition_Source is required in Entity_Type
Error (line 4): Logical_Consistency_Report is required in Data_Quality_Information
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Error (line 4): Source_Citation is required in Source_Information
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Error (line 4): Time_of_Day is not permitted in Process_Step
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25 errors: 2 misplaced, 16 missing, 7 bad_value

The Breakline XML Metadata file parsed with errors.

No Data to Test

The Bare-Earth DEM XML Metadata file parsed with errors.

Did not Pass: 25 errors: 2 misplaced, 16 missing, 7 bad_value

mp 2.9.14 - Peter N. Schweitzer (U.S. Geological Survey)

Info: input file = php8EH5vY.xml

Info: process date = 20111021

Info: process time = 17:08:29

Warning (line 4): Unknown extension element ignored: Esri

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Warning (line 4): Unknown extension element ignored: SyncOnce

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25 errors: 2 misplaced, 16 missing, 7 bad_value

Project QA/QC Report Review

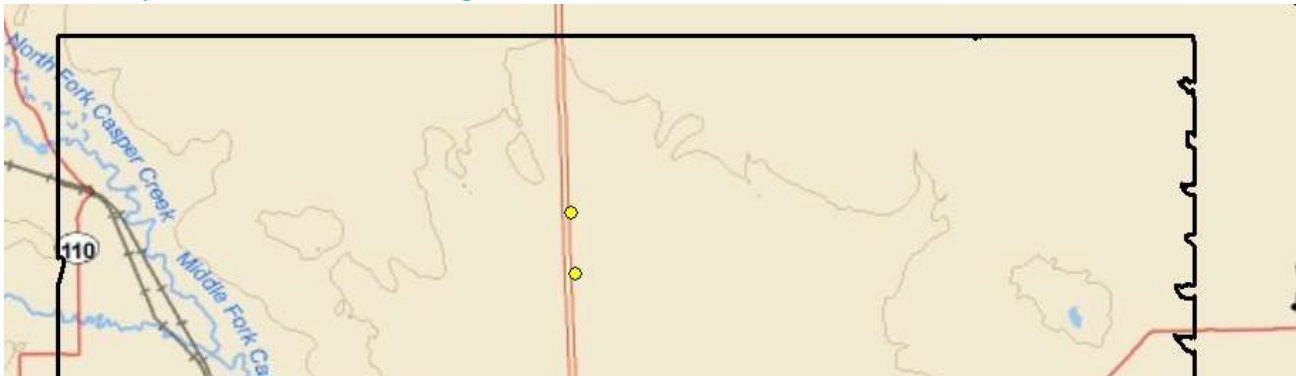
ASPRS recommends that checkpoint surveys be used to verify the vertical accuracy of LiDAR data sets. Checkpoints are to be collected by an independent survey firm licensed in the particular state(s) where the project is located. While subjective, checkpoints should be well distributed throughout the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

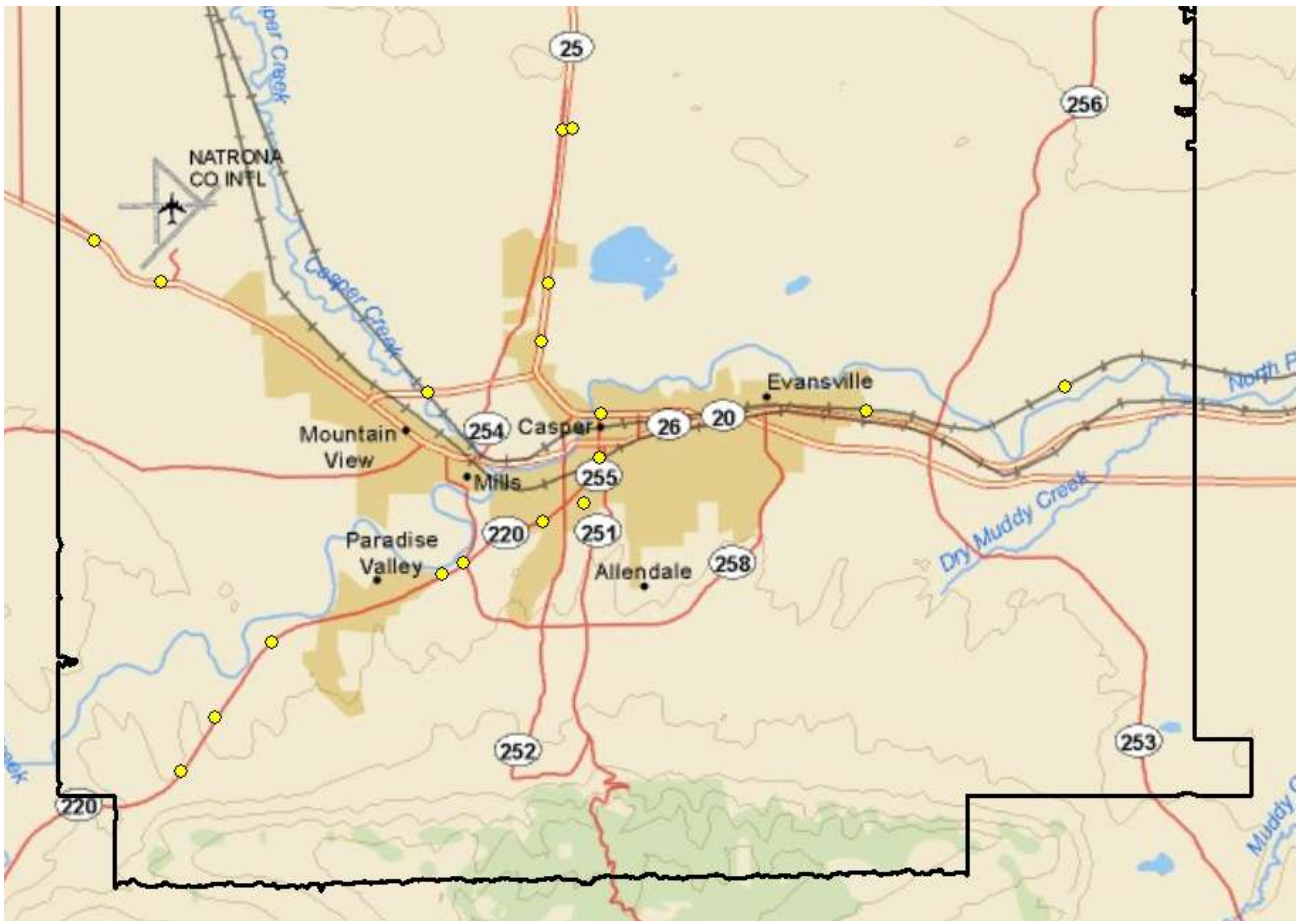
NSSDA and ASPRS require that a minimum of twenty checkpoints (thirty is preferred) are collected for each major land cover category represented in the LiDAR data. Checkpoints should be selected on flat terrain, or on uniformly sloping terrain in all directions from each checkpoint. They should not be 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?

No Suitable independent checkpoints were delivered with the data. XML metadata reports Vertical Accuracy for these Datasets; however, these metadata files and values are somewhat suspect. DEM were tested for FVA and CVA using the best 20 NGS Bench Marks Available in the Area.

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="not given"/> | <input type="text" value="centimeters"/> |
| Brush Lands and Low Trees | <input type="text" value="not given"/> | <input type="text" value="centimeters"/> |
| Forested Areas Fully Covered by Trees | <input type="text" value="not given"/> | <input type="text" value="centimeters"/> |
| Urban Areas with Dense Man-Made Structur... | <input type="text" value="not given"/> | <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.

Errors, Anomalies, Other Issues to document? Yes No

Image?

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

Image?

There are two sets of Classified LAS Tiles. One set was flown for a smaller NPS over the metropolitan area of Casper is estimated at 1.29583152897 U.S. feet and is used in reference to the 1ft (contour interval) LAS, this is less than the Scope of services targeted NPS of 3.921342 ft and is acceptable.
 . The other set has a higher estimated NPS over the entire AOI of 2.00766382669 U.S. feet which is less than the required 2.772807 -3.28083 ft, and is acceptable. NPS and Density are good enough for gridding DEM's up to the 1 -meter or 1/27th arc second cell size.

Image?

There are points classified to class 12 overlap class.

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 Breaklines Provided. However, the Landcover in this AOI should incorporate Breaklines, but since it is donated it is acceptable as is, but will not be recommended for the Hydro Enforced 1/3 NED. The Scope of Services document states that DTM's would be created with breakline enforcement, these were not received.

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 = or less. | Supplemental Vertical Accuracy @95th Percentile Error Target SVA = or less. | Consolidated Vertical Accuracy @95th Percentile Error Required CVA = 30.48 or less. |
|--|-------------|--|--|--|
| Open Terrain | unknown | 15 | | |
| Tall Weeds and Crops | | | not given | |
| Brush Lands and Low Trees | | | not given | |
| Forested Areas Fully Covered by Trees | | | not given | |
| Urban Areas with Dense Man-Made Structures | | | not given | |
| Consolidated | unknown | | | 15 |

QA performed Accuracy Calculations?

Calculated Accuracies

| Land Cover Category | # of Points | Fundamental Vertical Accuracy @95% Confidence Interval (Accuracy _z) Required FVA = N/A or less. | Supplemental Vertical Accuracy @95th Percentile Error Target SVA = N/A or less. | Consolidated Vertical Accuracy @95th Percentile Error Required CVA = 30.48 or less. |
|--|-------------|--|--|--|
| Open Terrain | 20 | 32.97208 | | |
| Tall Weeds and Crops | | | | |
| Brush Lands and Low Trees | | | | |
| Forested Areas Fully Covered by Trees | | | | |
| Urban Areas with Dense Man-Made Structures | | | | |
| Consolidated | 20 | | | 27.40683 |

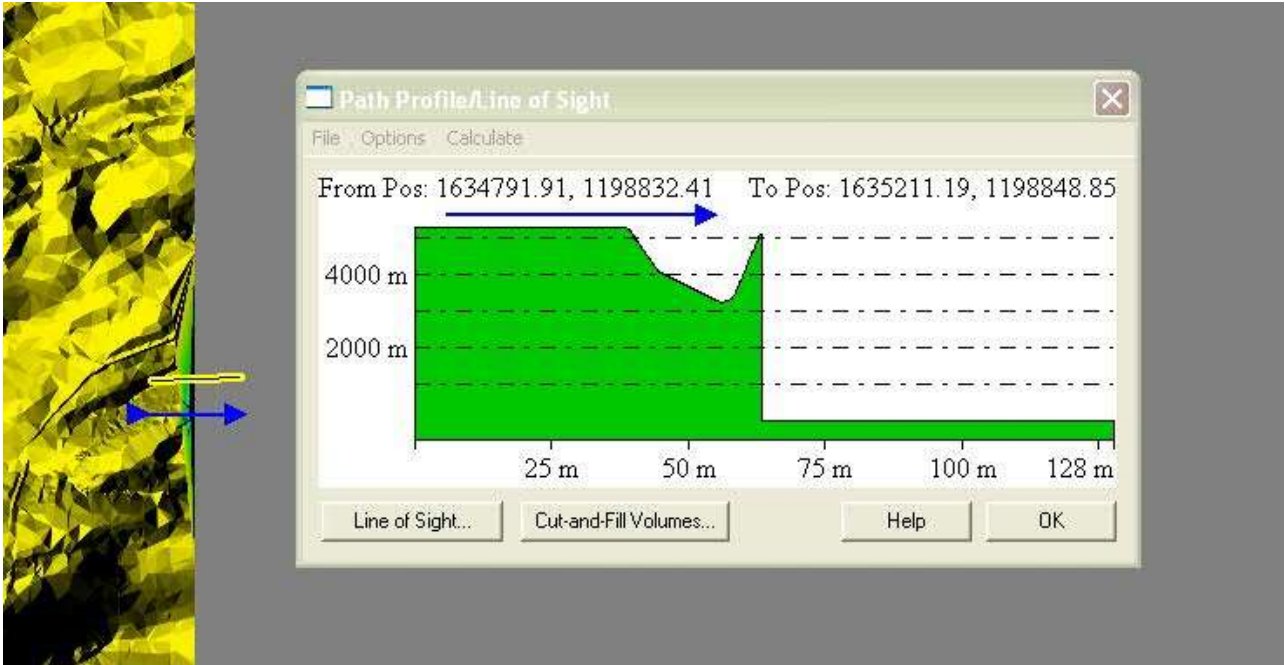
Based on this review, the USGS does not recommend the bare-earth DEM files for inclusion in the 1/3 Arc-Second National Elevation Dataset.

Based on this review, the USGS does not accept at this time the bare-earth DEM files.

Bare-Earth DEM Anomalies, Errors, Other Issues

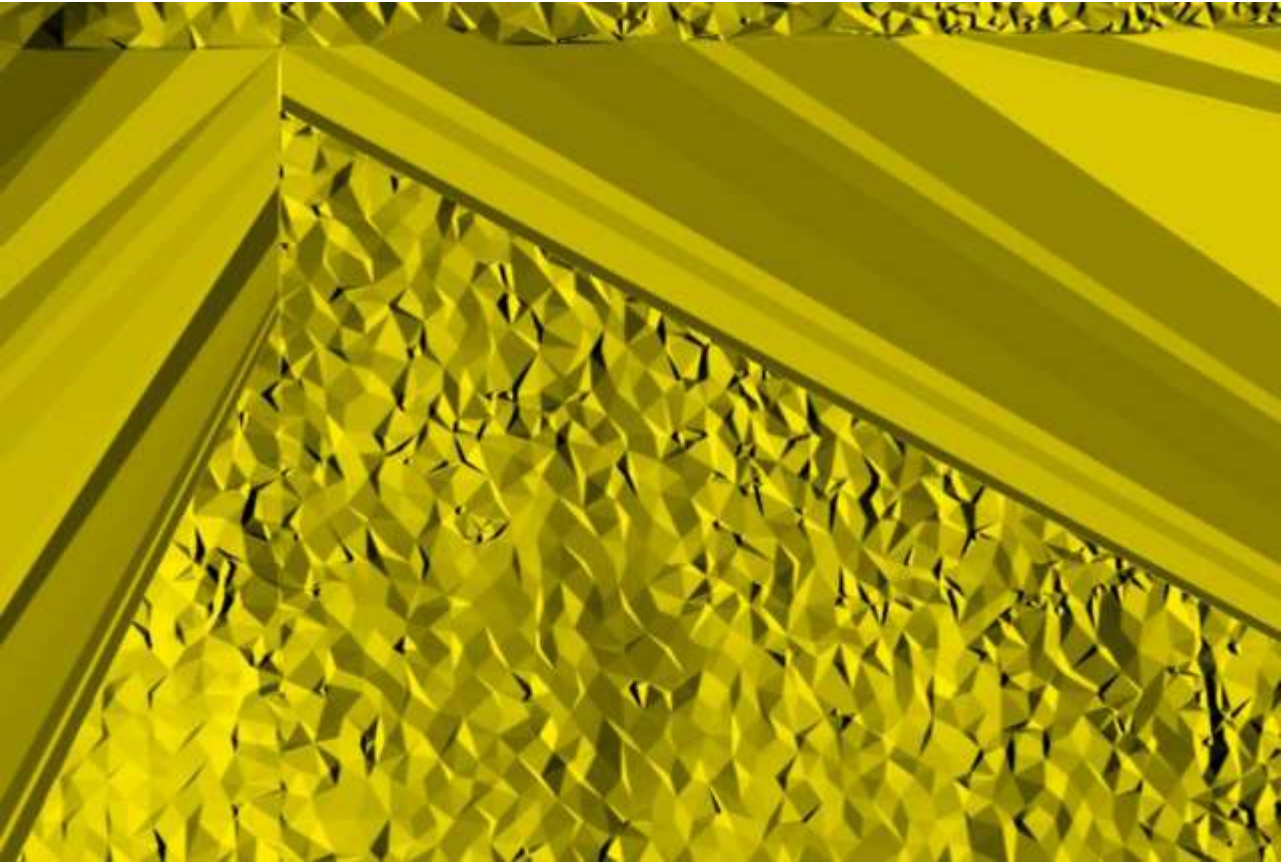
Errors, Anomalies, Other Issues to document? Yes No

Image?



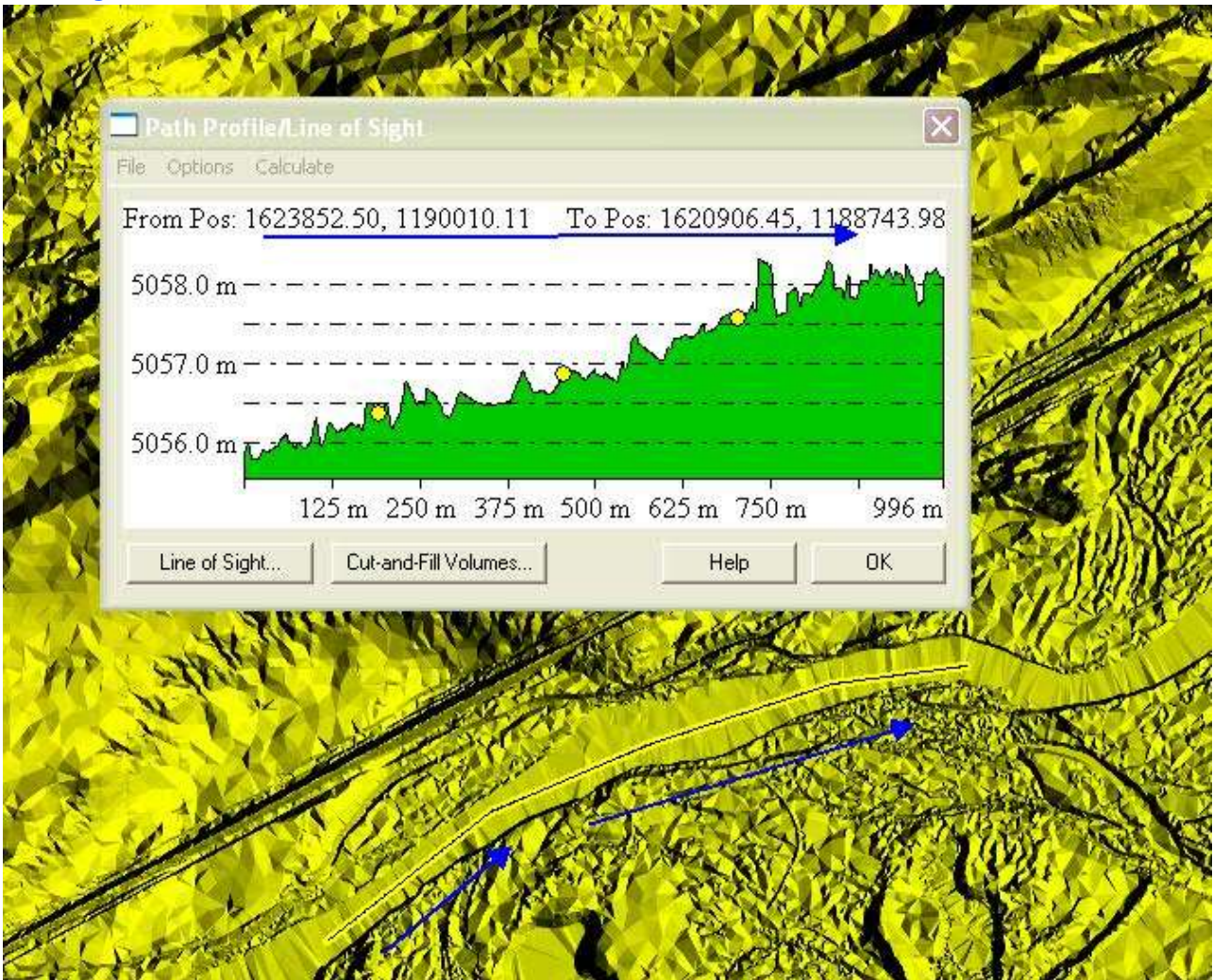
The Provided DEM's contain several instances of dips in excess of 1000 ft.

Image?



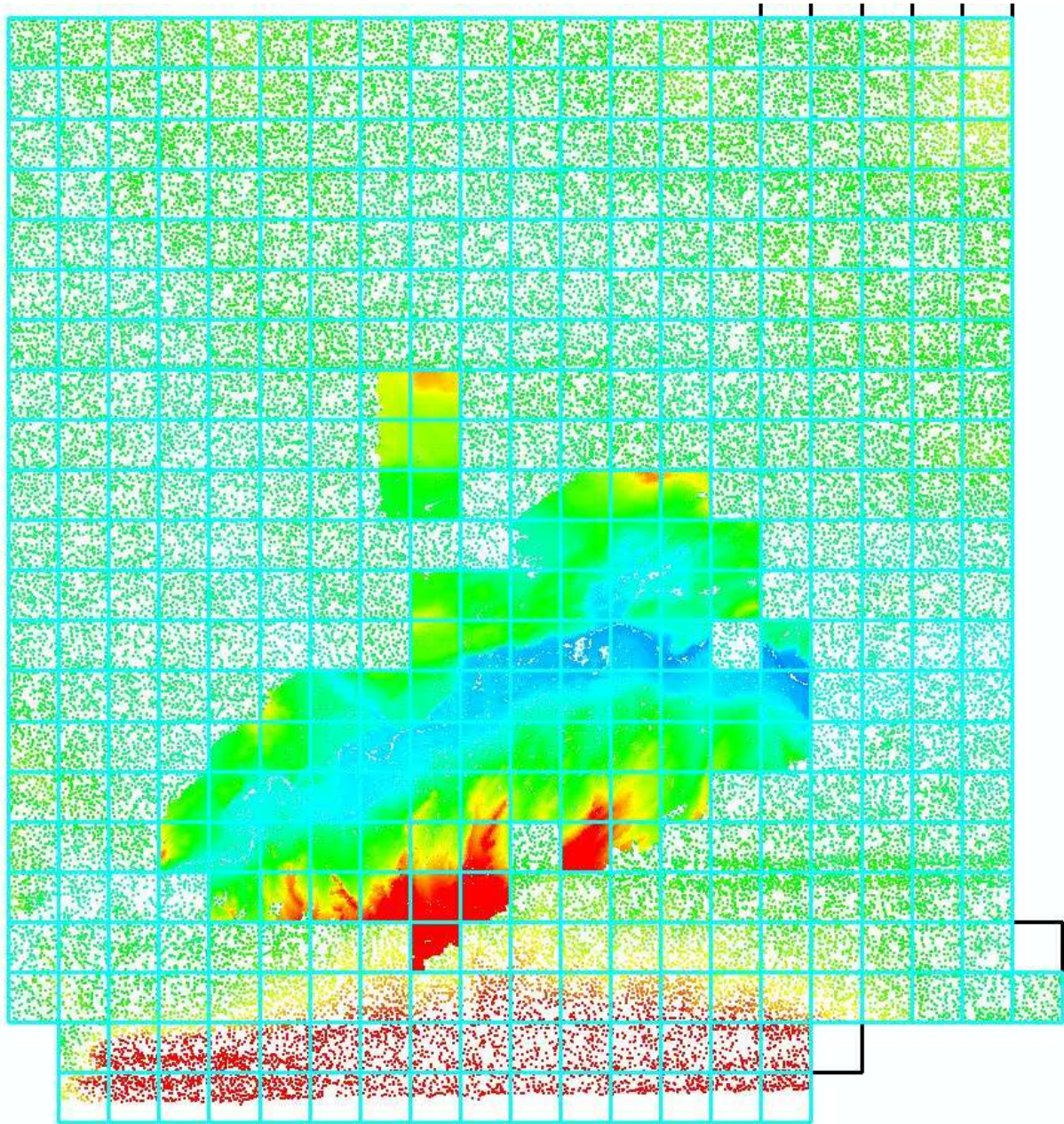
There are clear tinning issues between data tiles and overall texture is highly tinned as if DEM's were not created using the proper classes (2, 8).

Image?



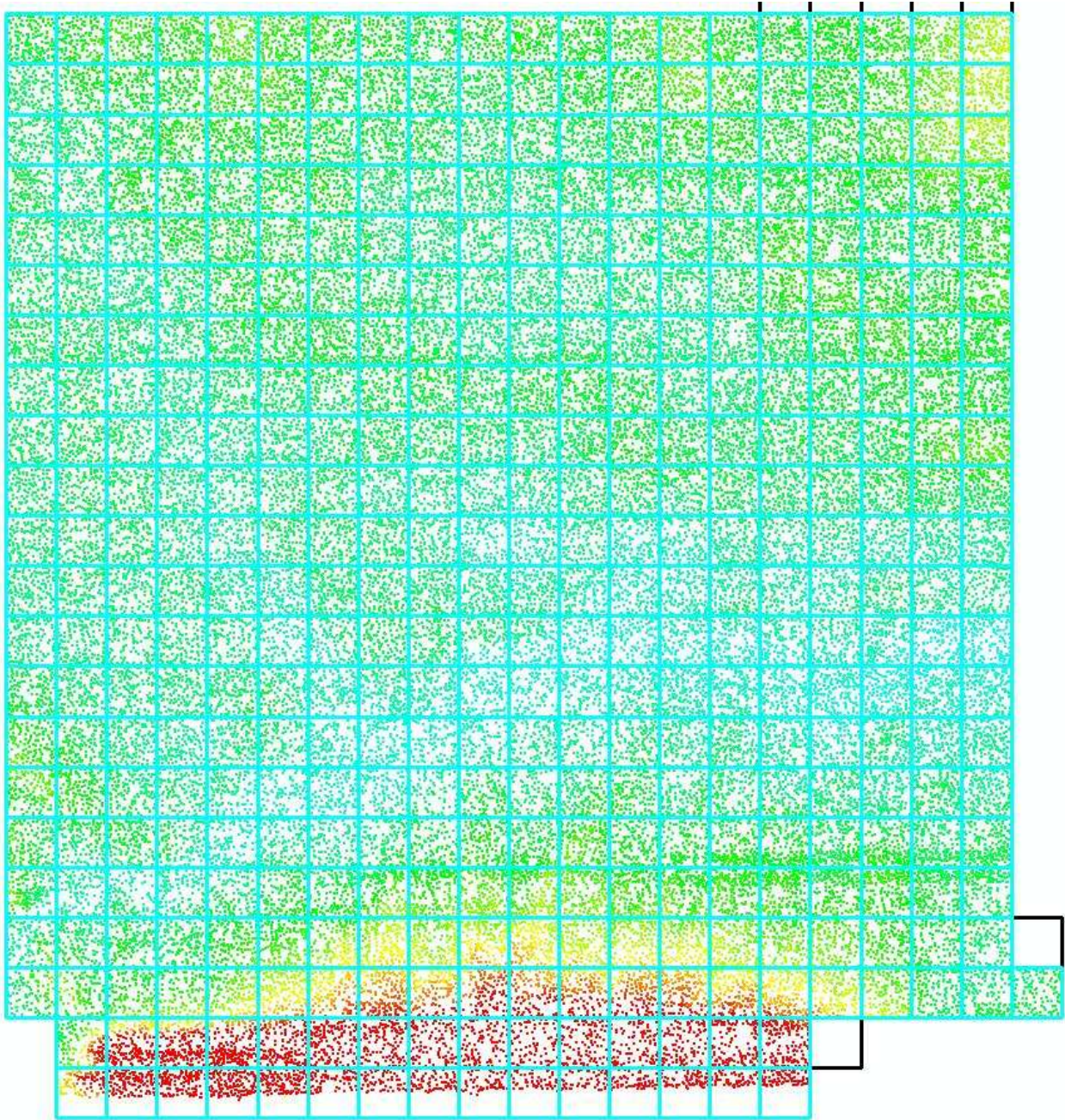
Hydro Features are not Hydro Conditioned or Breakline Enforced.

Image?



NGTOC re-gridded DEM's based on the combined point clouds (above) as well as just the 2ft-contour dense point cloud (below) and 1ft dense point cloud, these may be incorporated into the NED, but provided tiles will not.

Image?



Bare Earth Point Cloud of the 2ft- contour dense Lidar, shaded by elevation.

Image?

The XML Metadata appears suspect in that an NSSDA value of exactly 15cm in highly unlikely. The Value is strictly provided as is.

Image?

The Vertical Accuracy Values Found above are derived from the best (most likely to pass the dataset) 20 NGS Control Points available. The Scope of Services for the Casper Project calls for Vertical accuracy of "0.5 ft at the 90% for the 1foot contour LiDAR gridded DEM's" and for "1 ft at the 90% for the 2foot contour LiDAR gridded DEM's". It is not clear whether the 90% is referencing a confidence interval or 90th percentile. NGTOC reported accuracies are FVA at the 95% CI or standard USGS v13 NSSDA statistic. The CVA is reported at the 90th percentile. The CVA statistic passes the Scope of Services Spec if 90th Percentile is what the SOS refers to. The DEM's do not pass the v13 USGS standard Spec which would need a NSSDA value of less than 24.5 cm. However, as NGS control was used, the nature of the accuracy of that control is somewhat questionable (also NGS control does not allow for SVA's to be calculated at present) and actual accuracy could be more or less than what was found, but unless new high end control is provided for the AOI, it is as good as can be managed.

This is the end of the report.

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