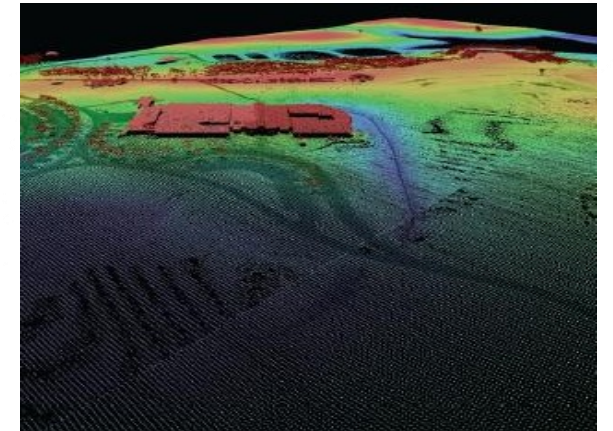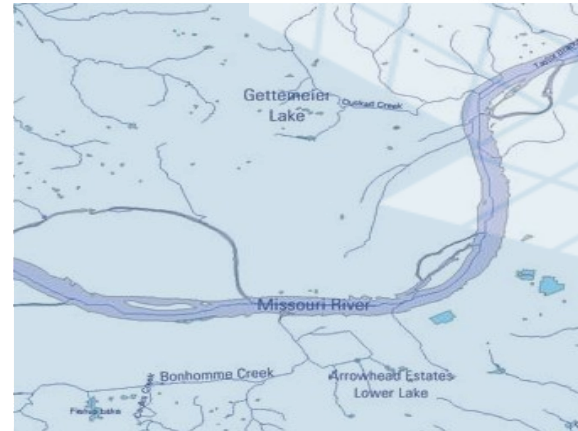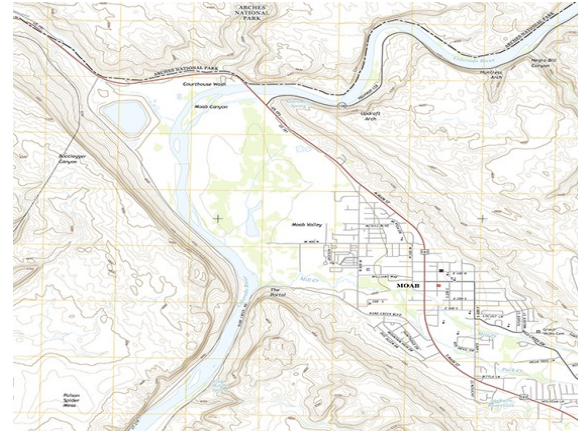# GPSC Technical Exchange

Barry Miller and Josh Nimetz

National Geospatial Program | National Geospatial Technical Operations Center

Virtual Web Conference

May 10, 2022

+ Topics for discussion

- Introduce Barry Miller as Acting Senior Elevation Lead until July 10th, 2022

- 3DEP Lidar Base Specification 2022 rev. A
  - https://www.usgs.gov/3dep/lidarspec
  - Consistent units of measure
    - No classification codes to identify overlap points
    - Survey point delivery (control points and checkpoints)
    - Drop delivery of waveform data

- Quantity of Checkpoints

- Maximum Surface Height Raster Resolution

- Swath Separation Imagery Intensity Modulation

- Number of Decimal Places

- Tile Index Generation

- Access to TEM materials – slides, recordings, etc.
  - https://rockyweb.usgs.gov/outgoing/3DEP_TEM/

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+ Lidar Base Specification 2022 rev A

- New version released April 6th, 2022
  - https://www.usgs.gov/3dep/lidarspec
  - Now a downloadable word document instead of a PDF to increase ADA accessibility

Revisions included in Lidar Base Specification 2022 rev. A:

Short name of revision	Status	Last updated
Consistent units of reference	Published	April 6, 2022
No classification codes to identify overlap points	Published	April 6, 2022
Survey point delivery	Published	April 6, 2022
Drop delivery of waveform data	Published	April 6, 2022

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■ Consistent units of reference

Units of Reference

- Horizontal and vertical units of measure will be in the same units (meters preferred). Mixed units (such as horizontal units of meters and vertical units of feet) are not recommended. Projects delivered with mixed units shall be considered as varying from the specification and will be noted as such in the spatial metadata.
- All references to the units of measure "Feet" and "Foot" shall specify "International," "Intl," "U.S. Survey," or "US."

■ Note, partners can still request mixed units or feet

■ The National Geodetic Survey has decided to deprecated the U.S. Survey Foot so you will be seeing less of this unit

■ https://www.federalregister.gov/documents/2020/10/05/2020-21902/deprecation-of-the-united-states-us-survey-foot#:~:text=This%20notice%20announces%20the%20final,meter%20exactly)%20in%20all%20applications

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- No classification codes to identify overlap points

Use of the LAS Overlap Bit Flag

- The overlap flag shall not be used for lidar point clouds intended for inclusion in 3DEP data holdings.

Point Classification

- The minimum, required classification scheme for lidar data is found in table 5.
- All points that fall within the minimum classification scheme (table 5) and not flagged as withheld shall be properly classified.
- Additional classes may be used on specific projects.
- Accuracy of point classification into classes beyond the minimum scheme (table 5) will not be assessed by the USGS, as documented in metadata.
- Assessing and verifying accuracy of point classification into classes beyond the minimum scheme will be the responsibility of the partner requesting the additional classes.
- No points in the classified LAS deliverable may remain assigned to Class 0 unless these points are flagged as withheld.
- Points classified as water will only be checked when associated with a breakline.
- Classification codes shall not be used in lieu of the overlap bit flag to identify overlap points.
- Model key points, if calculated, shall be identified using the key point bit flag as defined in LAS specification version 1.4–R15 (ASPRS, 2011). Model key points may, in addition, be identified using class 8 at the discretion of the data producer.

- To summarize, do not delineate overlap or overage by either using an "overlap class" or overlap bit flag

- If the overlap points are geometrically suspect, mark them as withheld.

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■ Survey point delivery

Survey Point Delivery

- Survey Points associated with the project shall be delivered in GeoPackage file format, consistent with the most recent published version of the GeoPackage Encoding Standard (presently OGC GeoPackage Encoding Standard (2021)). See figure 4 for an example.
  - The GeoPackage will contain all checkpoints utilized to validate the vertical accuracy of the project. Any checkpoints that were not utilized in the verification of the final vertical accuracy assessment are prohibited.
  - The GeoPackage may also contain all the control points associated with the project.
  - The GeoPackage shall be in the same CRS as the lidar data.
  - The CRS information of the GeoPackage shall adhere to all Well-Known Text requirements in the Data Processing and Handling section of this specification, with only the following exceptions:
    - The CRS information shall be recorded in the gpkg_spatial_ref_sys_table as defined in OGC GeoPackage Encoding Standard (2021).
    - The GeoPackage shall contain a single CRS entry.
  - GDAL version 2.4.1 or later or as otherwise agreed to in advance and specified in the Task Order, shall be used to populate the gpkg_spatial_ref_sys_table of the GeoPackage as defined in OGC GeoPackage Encoding Standard (2021).
  - The point features within the GeoPackage shall be Z-enabled.
  - The name of the GeoPackage shall contain only the USGS defined name of a project appended with "_Survey_Points" (for example, FL_Everglades_2020_D20_Survey_Points).

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File: Geopackage with a Points Layer that is Z enabled | File Naming Convention: PRJ(full name)_Survey_Points

Attribute Field (Name)	Attribute Field (Type/format)	Field length / limitation	Comment
unique_identifier	Text format	No limitation	Unique identifier that distinguishes the specific point from all other points within the file. The identifier shall be consistent with associated survey reports and images.
point_type	Text format	10 characters	Populated with one of the following values: NVA, VVA, Control, or BVA
comment	Text format	No limitation	May be null or empty. This field is for additional information the producer wishes to include regarding a specified point (for example, "bathymetry checkpoint at the edge of a waterbody.")
collection_date	Date format	yyyy-mm-dd	The specific date the point was surveyed expressed as yyyy-mm-dd.
source_geoid	Text format	No limitations	The source geoid.
source_horizontal_epsg	Integer format	No limitations	The source horizontal epsg.
source_horizontal_unit	Text format	No limitations	The source horizontal unit of measurement. Populated with one of the following values: meter, metre, U.S. Survey Feet, International Feet.
source_vertical_epsg	Integer format	No limitations	The source vertical epsg.
source_vertical_unit	Text format	No limitations	The source vertical unit of measurement.
source_easting	Real format	3 decimal places	The source easting coordinate, not to exceed three decimal places in precision.
source_northing	Real format	3 decimal places	The source northing coordinate, not to exceed three decimal places in precision.
source_elevation	Real format	3 decimal places	The source elevation, not to exceed three decimal places in precision.
project_id	Integer format	No limitations	Numerical value of project assigned by USGS (previously referred to as the work package identification for a project).

+ Lidar Base Specification 2022 rev A

- Survey point delivery continued…
  - Please use the Geopackage template discussed in the March 8, 2022 TEM
    - https://rockyweb.usgs.gov/outgoing/3DEP_TEM/20220308/

- Drop delivery of waveform data
  - We removed all references to waveform collection and delivery from Collection Requirements, Data Processing and Handling, and Deliverables

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+ Lidar Base Specification – Future Revisions

- Remember to review the LBS revisions page
  - https://www.usgs.gov/ngp-standards-and-specifications/lidar-base-specification-revision-status

- USGS has moved to a new listserv for email notifications
  - No action required – current emails on file should be ported over to new system
  - If you're not on the list, you can sign-up here:
    https://public.govdelivery.com/accounts/USDOIGS/subscriber/new?topic_id=USDOIGS_17

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+ Quantity of Checkpoints

- ASPRS is currently looking into updating this requirement

- Until it is updated, we ask that you double check that you have the correct number of NVA and VVA Checkpoints
  - This is particularly important if a task order is modified to increase the area

- Please reference the "NVA-VVA_Required_Checkpoints_Table" excel in: https://rockyweb.usgs.gov/outgoing/3DEP_TEM/20220510/

Project Area (Square KM)	Project Area (Square Miles)	Vertical and Horizontal Accuracy Testing of Elevation Data Sets		
		Number of Static 3D Checkpoints in NVA*	Number of Static 3D Checkpoints in VVA	Total Number of Static 3D Checkpoints
≤500	≤193	20	5	25
501 - 750	193.4 - 289.6	20	10	30
751 - 1000	290.0 - 386.1	25	15	40
1001 - 1250	386.5 - 482.6	30	20	50
1251 - 1500	483.0 - 579.2	35	25	60
1501 - 1750	579.5 - 675.7	40	30	70
1751 - 2000	676.1 - 772.2	45	35	80
2001 - 2250	772.6 - 868.7	50	40	90
2251 - 2500	869.1 - 965.3	55	45	100
2501 - 3000	965.6 - 1158.3	58	47	105

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+ MSHR – Spatial Resolution

- USGS will now accept MSHRs with spatial resolution (pixel size) up to 4 * NPS

- Intent is to make sure pixels contain valid signal and are not data voids
  - Exceptions to this are for areas where voids are expected such as over open water

- This is similar to the spatial resolution requirement for SSIs

- We are still deliberating this change
  - Would it be better to have a pixel size based on a multiple of the DEM raster resolution?
  - If we keep 4 * NPS, should QL1 products be 6 * NPS?
  - What are your thoughts on this?

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# + Swath Separation Imagery Intensity Modulation

- SSI images need to be modulated by intensity

  - o Image Creation:
    - All returns, single returns, or last returns shall be used to create the images.
    - All point classes and flags shall be enabled when creating the images and points flagged as withheld or classified as noise shall be excluded.
    - Elevation values and differences shall not be subjected to a threshold or otherwise clipped so all differences are represented.
    - The images will be derived from TINs to reduce the number of false difference values on slopes; however, other algorithms are acceptable.
    - The images shall consist of a 50 percent transparent RGB layer overlaying the lidar intensity image.
    - The images shall use at least three color levels wherever two or more swaths overlap within a pixel.

- We have seen many examples of SSI images where no intensity is used at all or where the transparency on the RGB layer is so low that you cannot see the intensity under the colors
  - This makes it much harder to understand if you are in vegetated areas
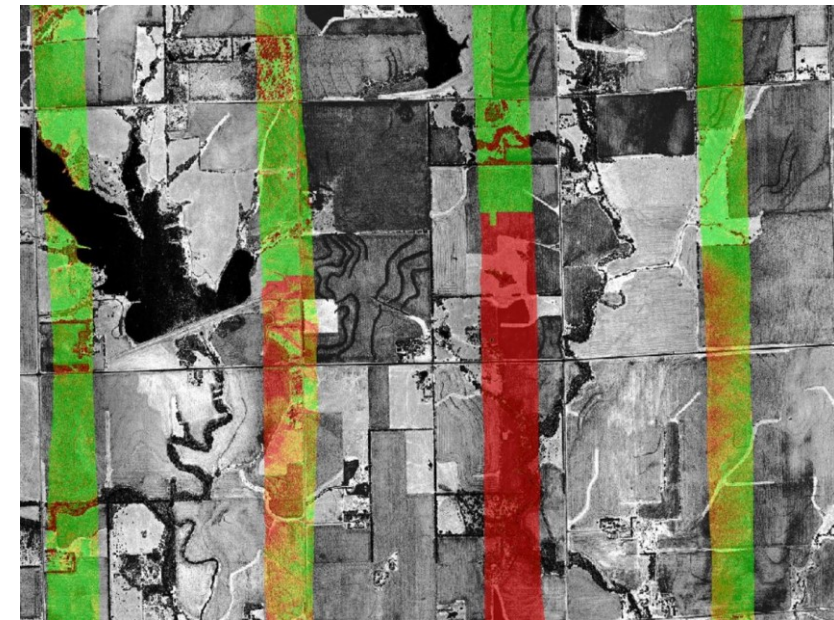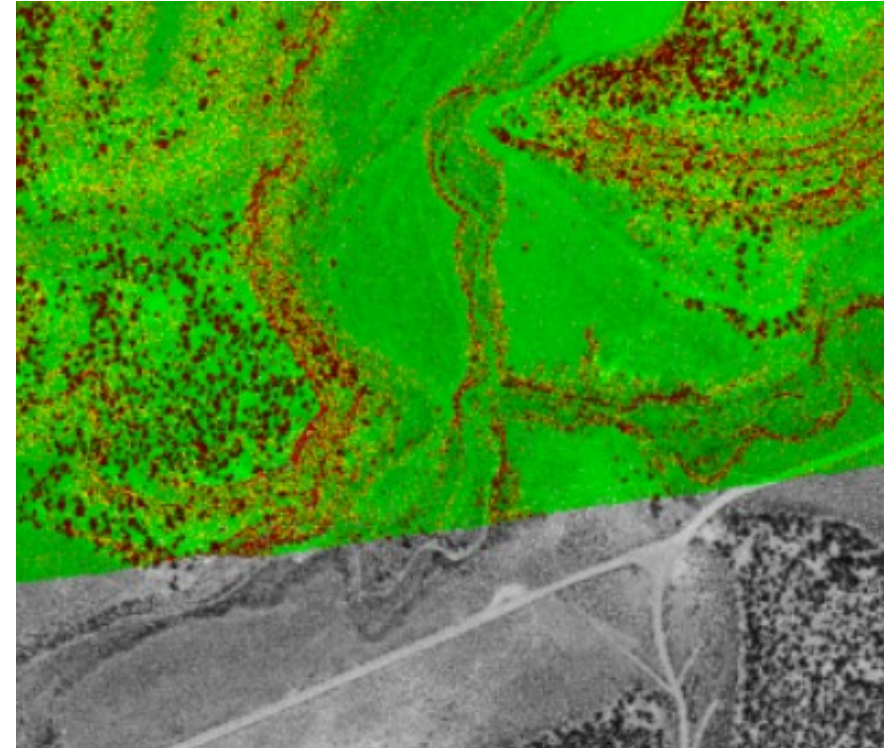
+ Swath Separation Imagery Intensity Modulation

- SSI images need to be modulated by intensity
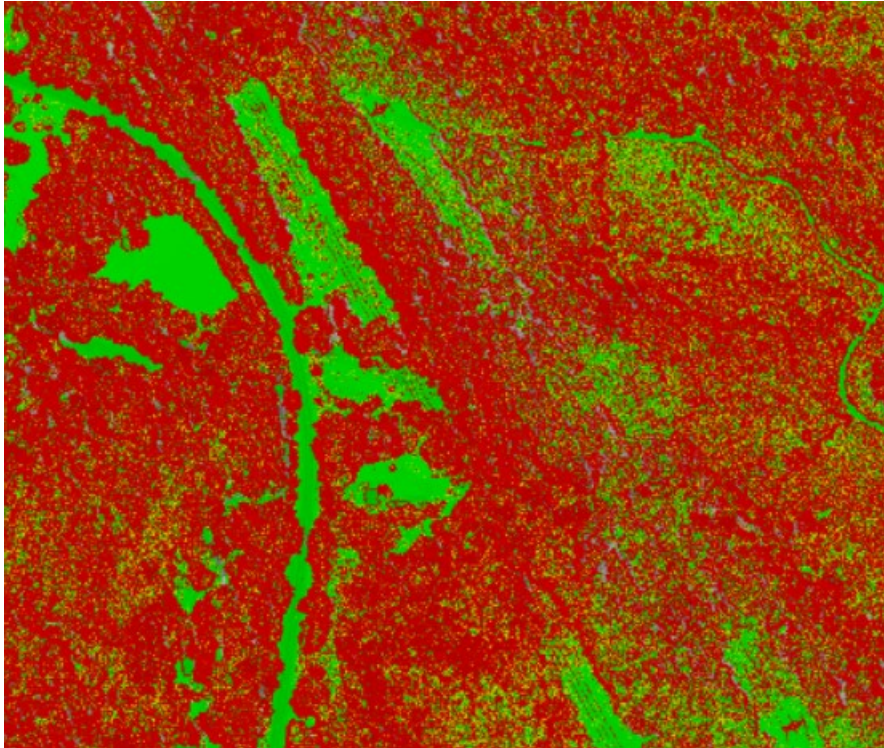
- Intensity very difficult to see

- Intensity easier to see

+ Number of Decimal Places

- We are considering the following change to the LBS
  - Airborne acquired data shall be reported with a level of precision of 1/100 (0.01)
  - Survey point data shall be reported with a level of precision of 1/1000 (0.001)

- The intent would be to reduce the size of lidar point clouds by not reporting unnecessary digits past the accuracy of the lidar sensor or survey equipment

- This would also help manage user expectations on the accuracy of the data

- What are your thoughts on this change?

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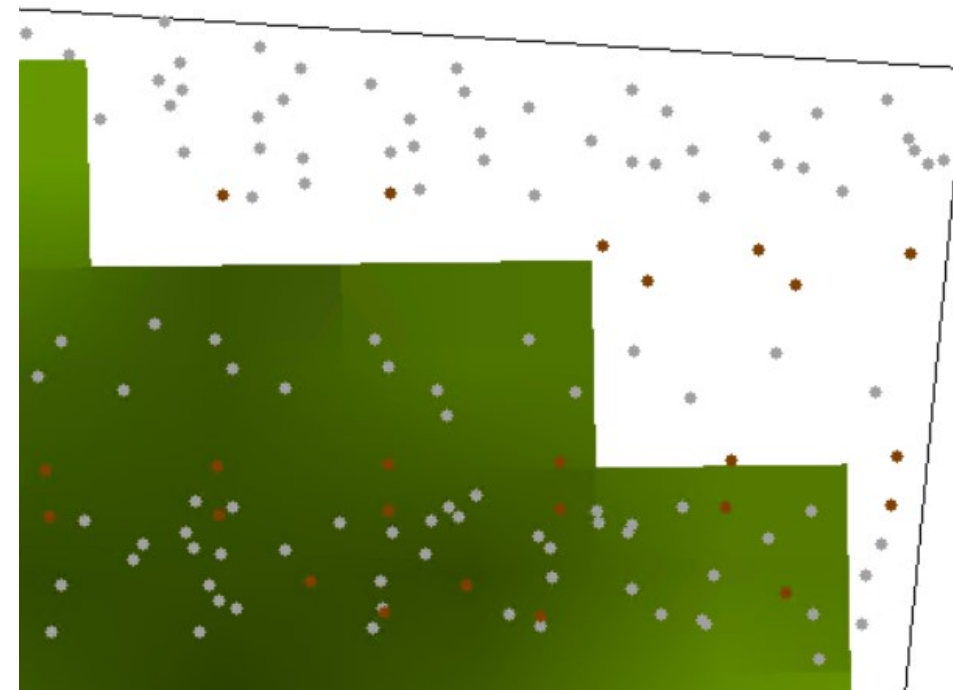
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+ Tile Index Generation

- We have seen examples of tiling schemes generated in different projections (such as Albers Equal Area) that are reprojected to UTM or State Plane to match the lidar deliverable

  - This leads to issues where the tiles are not orthogonal with the raster pixels

  - As a result, the raster DEMs end a fraction of a pixel early and create slight data voids

- Propose the following change:

Tiles

- A single nonoverlapping project tiling scheme will be established and agreed upon by the data producer and the USGS–NGP before collection.
- The tiling scheme will be used for all tiled deliverables:
  - ~~The tiling scheme shall use the same coordinate reference system and units as the data.~~
  - The tiling scheme shall use and be generated in the same coordinate reference system and units as the data to align orthogonally with the raster pixels.

- What are your thoughts on this change?

Thank You!
Let's Talk…

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