

## MT Statewide Phase4 Delivery 5 LIDAR PROCESSING REPORT

Project ID: 231442  
Work Unit: 300232

Prepared for:



National Map Help Desk: [tnm\\_help@usgs.gov](mailto:tnm_help@usgs.gov)

Submitted: December 1, 2023

# 2023

Prepared by:

# N|V|5 GEOSPATIAL

# Contents

- 1. Summary / Scope ..... 1**
  - 1.1. Summary ..... 1
  - 1.2. Scope ..... 1
  - 1.3. Coverage..... 1
  - 1.4. Duration..... 1
  - 1.5. Issues ..... 1
- 2. Planning / Equipment ..... 4**
  - 2.1. Flight Planning ..... 4
  - 2.2. Lidar Sensor ..... 4
  - 2.3. Aircraft..... 6
  - 2.4. Time Period ..... 7
  - 2.4. Time Period (cont.) ..... 8
- 3. Processing Summary ..... 9**
  - 3.1. Flight Logs..... 9
  - 3.2. Lidar Processing..... 10
  - 3.3. LAS Classification Scheme ..... 11
  - 3.4. Classified LAS Processing ..... 12
  - 3.5. Hydro-Flattened Breakline Processing..... 12
  - 3.6. Hydro-Flattened Raster DEM Processing ..... 13
  - 3.7. Intensity Image Processing ..... 13
  - 3.8. Swath Separation Raster Processing..... 13
  - 3.9. Maximum Surface Height Raster Processing ..... 14
  - 3.10. Contour Processing..... 14
- 4. Project Coverage Verification ..... 16**
- 6. Geometric Accuracy ..... 17**
  - 6.1. Horizontal Accuracy ..... 17
  - 6.2. Relative Vertical Accuracy..... 18
- Project Report Appendices .....xix**
- Appendix A.....xx**
  - Flight Logs.....xx

## List of Figures

Figure 1. Work Unit Boundary ..... 3  
Figure 2. Riegl VQ1560ii Lidar Sensor ..... 5  
Figure 3. NV5 Geospatial’s Aircraft ..... 6  
Figure 4. Lidar Tile Layout ..... 15  
Figure 5. Lidar Coverage ..... 16

## List of Tables

Table 1. Originally Planned Lidar Specifications ..... 1  
Table 2. Lidar System Specifications ..... 5  
Table 3. LAS Classifications ..... 11

## List of Appendices

Appendix A: Flight Logs

# 1. Summary / Scope

## 1.1. Summary

This report contains a summary of the MT Statewide Phase4 Delivery 5, Work Unit 300232 lidar acquisition task order, issued by USGS under their Contract 140G0221D0016 on 5/27/2022. The task order yielded a work unit area covering 263 square miles over Montana at Quality Level 1. The intent of this document is only to provide specific validation information for the data acquisition/collection, processing, and production of deliverables completed as specified in the task order.

## 1.2. Scope

Aerial topographic lidar was acquired using state of the art technology along with the necessary surveyed ground control points (GCPs) and airborne GPS and inertial navigation systems. The aerial data collection was designed with the following specifications listed in Table 1 below.

**Table 1. Originally Planned Lidar Specifications**

Average Point Density	Flight Altitude (AGL)	Field of View	Minimum Side Overlap	RMSEz
8 pts / m2	3050 m	58.5°	50%	≤ 10 cm

## 1.3. Coverage

The work unit boundary covers 263 square miles over Montana. Work unit extents are shown in Figure 1.

## 1.4. Duration

Lidar data was acquired from July 20, 2022 to September 10, 2022 in 20 total lifts. See “Section: 2.4. Time Period” for more details.

## 1.5. Issues

There were no issues to report.

<b>MT Statewide Phase4 Delivery 5 Work Unit 300232</b> <b>Projected Coordinate System: State Plane Montana FIPS 2500</b> <b>Horizontal Datum: NAD83 (2011)</b> <b>Vertical Datum: NAVD88 (GEOID 18)</b> <b>Units: Meters</b>	
Lidar Point Cloud	Classified Point Cloud in .LAS 1.4 format
Rasters	<ul style="list-style-type: none"> <li>• 0.5-meter Hydro-flattened Bare Earth Digital Elevation Model (DEM) in GeoTIFF format</li> <li>• 0.5-meter Intensity images in GeoTIFF format</li> <li>• 1-meter Maximum Surface Height Raster</li> <li>• 1-meter Swath Separation Images</li> </ul>
Vectors	Shapefiles (*.shp) <ul style="list-style-type: none"> <li>• Project Boundary</li> <li>• Lidar Tile Index</li> <li>• Contours</li> </ul> Geodatabase (*.gdb) <ul style="list-style-type: none"> <li>• Continuous Hydro-flattened Breaklines</li> </ul>
Reports	Reports in PDF format <ul style="list-style-type: none"> <li>• Focus on Delivery</li> <li>• Survey Report</li> <li>• Processing Report</li> </ul>
Metadata	XML Files (*.xml) <ul style="list-style-type: none"> <li>• Breaklines</li> <li>• Classified Point Cloud</li> <li>• DEM</li> <li>• Contours</li> <li>• Intensity Imagery</li> </ul>

# MT Statewide Phase4 Delivery 5 Work Unit 300232 Boundary

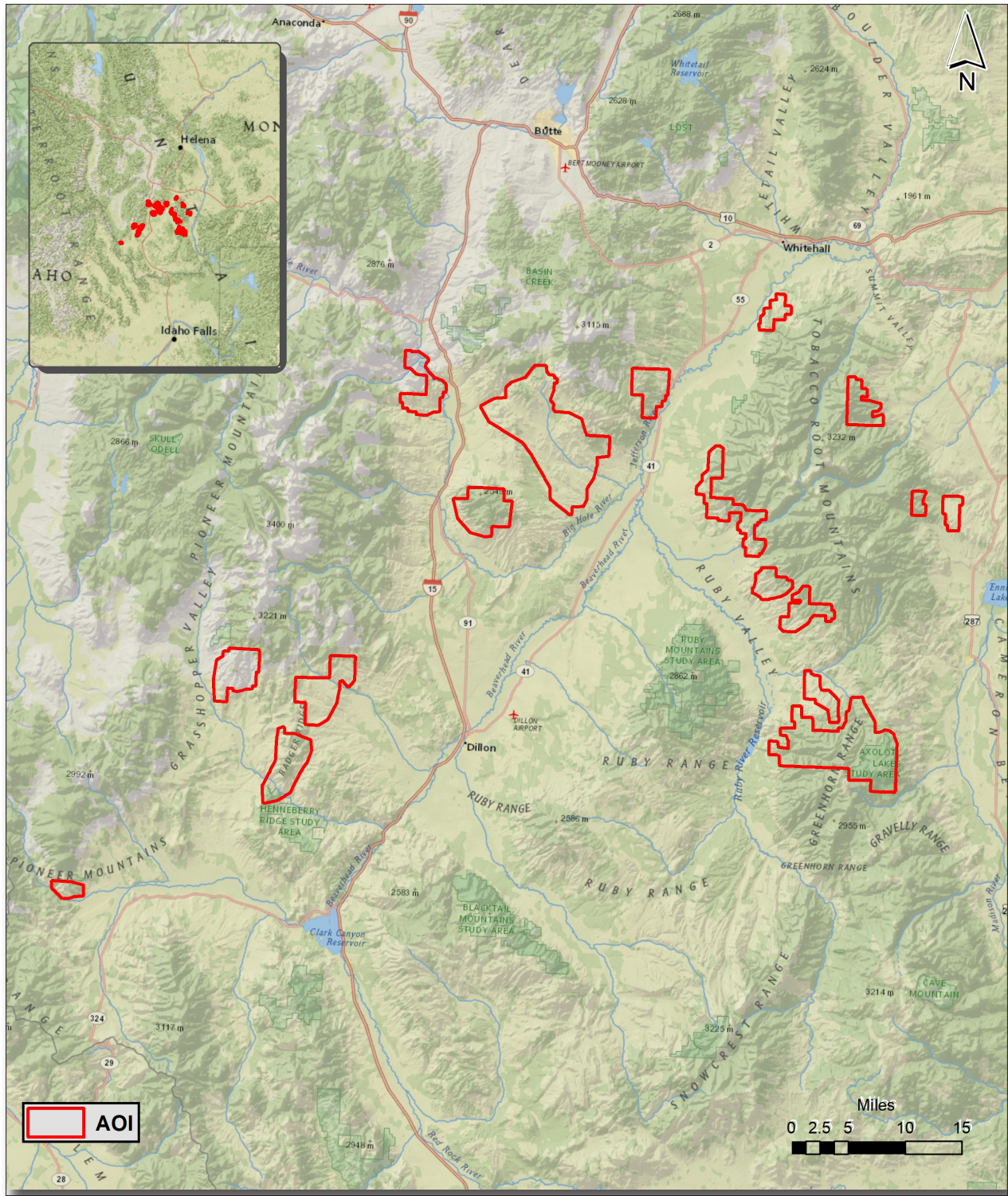


Figure 1. Work Unit Boundary

## 2. Planning / Equipment

### 2.1. Flight Planning

Flight planning was based on the unique project requirements and characteristics of the project site. The basis of planning included: required accuracies, type of development, amount / type of vegetation within project area, required data posting, and potential altitude restrictions for flights in project vicinity.

Detailed project flight planning calculations were performed for the project using RiPARAMETER planning software.

### 2.2. Lidar Sensor

NV5 Geospatial utilized Riegl VQ1560ii lidar sensors (Figure 2), serial number(s) 3061, 4046, and 4892, for data acquisition.

The Riegl 1560ii system is a dual channel waveform processing airborne scanning system. It has a laser pulse repetition rate of up to 4 MHz resulting in up to 2.66 million measurements per second. The system utilizes a Multi-Pulse in the Air option (MPIA) and an integrated IMU/GNSS unit.

A brief summary of the aerial acquisition parameters for the project are shown in the lidar System Specifications in Table 2.

**Table 2. Lidar System Specifications**

		Riegl VQ1560ii (SN3061)	Riegl VQ1560ii (SN4046)	Riegl VQ1560ii (SN4892)
<b>Terrain and Aircraft Scanner</b>	Flying Height	3050 m	3050 m	3050 m
	Recommended Ground Speed	145 kts	145 kts	145 kts
<b>Scanner</b>	Field of View	58.5°	58.5°	58.5°
	Scan Rate Setting Used	2 x 130 lps	2 x 130 lps	2 x 130 lps
<b>Laser</b>	Laser Pulse Rate Used	2 x 780 kHz	2 x 780 kHz	2 x 780 kHz
	Multi Pulse in Air Mode	YES	YES	YES
<b>Coverage</b>	Full Swath Width	3416 m	3416 m	3416 m
	Line Spacing	0.56 m	0.56 m	0.56 m
<b>Point Spacing and Density</b>	Average Nominal Point Spacing	0.35 m	0.35 m	0.35 m
	Average Point Density	8 pts / m <sup>2</sup>	8 pts / m <sup>2</sup>	8 pts / m <sup>2</sup>

**Figure 2. Riegl VQ1560ii Lidar Sensor**





## 2.3. Aircraft

All flights for the project were accomplished through the use of customized aircraft. Plane type and tail numbers are listed below.

### Lidar Collection Planes

- CESSNA 208B, Tail Numbers: N704MD, N22TE
- CESSNA 208, Tail Number: N840JA

These aircraft provided an ideal, stable aerial base for lidar acquisition. These aerial platforms have relatively fast cruise speeds, which are beneficial for project mobilization / demobilization while maintaining relatively slow stall speeds, proving ideal for collection of high-density, consistent data posting using a state-of-the-art lidar system. NV5 Geospatial's operating aircraft can be seen in Figure 3 below.

**Figure 3. NV5 Geospatial's Aircraft**



## 2.4. Time Period

Project specific flights were conducted between July 20, 2022 and September 10, 2022. Twenty aircraft lifts were completed. Accomplished lifts are listed below.

Lift	Start UTC	End UTC
07202022A (SN3061,N704MD)	7/20/2022 4:12:40 PM	7/20/2022 6:14:51 PM
07212022A (SN3061,N704MD)	7/21/2022 5:04:18 PM	7/21/2022 7:33:27 PM
07222022A (SN3061,N704MD)	7/22/2022 3:06:45 PM	7/22/2022 6:19:00 PM
07232022A (SN3061,N704MD)	7/23/2022 2:56:48 PM	7/23/2022 8:00:46 PM
07242022A (SN3061,N704MD)	7/24/2022 2:41:16 PM	7/24/2022 4:12:54 PM
07312022A (SN3061,N704MD)	7/31/2022 2:42:27 PM	7/31/2022 4:51:54 PM
08012022A (SN3061,N704MD)	8/01/2022 3:16:59 PM	8/01/2022 6:01:25 PM
08022022A (SN3061,N704MD)	8/02/2022 3:02:19 PM	8/02/2022 4:37:21 PM
08232022A (SN4892,N22TE)	8/23/2022 5:03:48 PM	8/23/2022 5:35:18 PM
08252022A (SN4892,N22TE)	8/25/2022 3:09:11 PM	8/25/2022 4:28:46 PM
08292022A (SN4892,N22TE)	8/29/2022 5:23:41 PM	8/29/2022 6:24:23 PM
08302022A (SN4892,N22TE)	8/30/2022 2:26:59 PM	8/30/2022 4:12:16 PM
09012022A (SN4892,N22TE)	9/01/2022 4:19:06 PM	9/01/2022 7:12:28 PM
09032022A (SN4046,N22TE)	9/03/2022 2:26:49 PM	9/03/2022 7:54:19 PM
09042022A (SN4046,N22TE)	9/04/2022 3:00:49 PM	9/04/2022 6:52:26 PM
09042022A (SN4892,N22TE)	9/04/2022 2:21:50 PM	9/04/2022 7:20:41 PM
09052022A (SN4046,N22TE)	9/05/2022 4:31:35 PM	9/05/2022 6:32:39 PM

## 2.4. Time Period (cont.)

Project specific flights were conducted between July 20, 2022 and September 10, 2022. Twenty aircraft lifts were completed. Accomplished lifts are listed below.

Lift	Start UTC	End UTC
09052022A (SN4892,N22TE)	9/05/2022 2:22:53 PM	9/05/2022 5:46:41 PM
09072022A2 (SN4892,N22TE)	9/07/2022 4:10:28 PM	9/07/2022 4:52:47 PM
09102022A (SN4892,N22TE)	9/10/2022 7:22:30 PM	9/10/2022 7:40:58 PM

## 3. Processing Summary

### 3.1. Flight Logs

Flight logs were completed by Lidar sensor technicians for each mission during acquisition. These logs depict a variety of information, including:

- Job / Project #
- Flight Date / Lift Number
- FOV (Field of View)
- Scan Rate (HZ)
- Pulse Rate Frequency (Hz)
- Ground Speed
- Altitude
- Base Station
- PDOP avoidance times
- Flight Line #
- Flight Line Start and Stop Times
- Flight Line Altitude (AMSL)
- Heading
- Speed
- Returns
- Crab

Notes: (Visibility, winds, ride, weather, temperature, dew point, pressure, etc). Project specific flight logs for each sortie are available in Appendix A.

### 3.2. Lidar Processing

Applanix + POSPac software was used for post-processing of airborne GPS and inertial data (IMU), which is critical to the positioning and orientation of the lidar sensor during all flights. Applanix POSPac combines aircraft raw trajectory data with stationary GPS base station data yielding a “Smoothed Best Estimate Trajectory” (SBET) necessary for additional post processing software to develop the resulting geo-referenced point cloud from the lidar missions.

During the sensor trajectory processing (combining GPS & IMU datasets) certain statistical graphs and tables are generated within the Applanix POSPac processing environment which are commonly used as indicators of processing stability and accuracy. This data for analysis include: max horizontal / vertical GPS variance, separation plot, altitude plot, PDOP plot, base station baseline length, processing mode, number of satellite vehicles, and mission trajectory.

Point clouds in flightline swath format were created using the RiPROCESS software. The generated point cloud is the mathematical three dimensional composite of all returns from all laser pulses as determined from the aerial mission. Each flightline swath point cloud was calibrated using Strip Align software that corrects systematic geometric errors and improves the relative and absolute accuracy of the flightline swath point cloud. The calibrated point cloud swaths were imported into GeoCue distributive processing software and the imported data was then tiled so further processing could take place in TerraScan software. Using TerraScan, the vertical accuracy of the surveyed ground control was tested and any vertical bias was removed from the data. TerraScan and TerraModeler software packages were then used for automated data classification and manual cleanup. The data were manually reviewed and any remaining artifacts removed using functionality provided by TerraScan and TerraModeler.

DEMs and Intensity Images are then generated using proprietary software. In the bare earth surface model, above-ground features are excluded from the data set. Global Mapper is used as a final check of the bare earth dataset.

Finally, proprietary software is used to perform statistical analysis of the LAS files.

Software	Version
Applanix + POSPac	8.6
RiPROCESS	1.8.6
Microstation Connect	10.16.02.34
GeoCue	2020.1.22.1
Global Mapper	19.1;20.1
TerraModeler	21.008
TerraScan	21.016
TerraMatch	21.007
StripAlign	2.21

### 3.3. LAS Classification Scheme

The classification classes are determined by Lidar Base Specifications 2021, Revision A and are an industry standard for the classification of lidar point clouds. All data starts the process as Class 1 (Unclassified), and then through automated classification routines, the classifications are determined using TerraScan macro processing.

The classes used in the dataset are as follows and have the following descriptions:

**Table 3. LAS Classifications**

	Classification Name	Description
1	Processed, but Unclassified	Laser returns that are not included in the bare earth class, or any other project classification
2	Bare earth	Laser returns that are determined to be bare earth using automated and manual cleaning algorithms
7	Low Noise	Laser returns that are often associated with scattering from reflective surfaces, or artificial points below the bare earth surface
9	Water	Laser returns that are found inside of hydro features
17	Bridge Deck	Laser returns falling on bridge decks
18	High Noise	Laser returns that are often associated with birds or artificial points above the bare earth surface
20	Ignored Ground	Bare earth points that fall within the given threshold of a collected hydro feature.

### 3.4. Classified LAS Processing

The bare earth surface is then manually reviewed to ensure correct classification on the Class 2 (Ground) points. After the bare- earth surface is finalized; it is then used to generate all hydro-breaklines through heads-up digitization.

All ground (ASPRS Class 2) lidar data inside of the Lake Pond and Double Line Drain hydro flattening breaklines were then classified to water (ASPRS Class 9) using proprietary tools. A buffer of 1.5 feet/0.5 meter was also used around each hydro flattened feature to classify these ground (ASPRS Class 2) points to Ignored ground (ASPRS Class 20). All Lake Pond Island and Double Line Drain Island features were checked to ensure that the ground (ASPRS Class 2) points were reclassified to the correct classification after the automated classification was completed.

Any noise that was identified either through manual review or automated routines was classified to the appropriate class (ASPRS Class 7 and/or ASPRS Class 18) followed by flagging with the withheld bit.

All data was manually reviewed and any remaining artifacts removed using functionality provided by TerraScan and TerraModeler. Global Mapper is used as a final check of the bare earth dataset. GeoCue was then used to create the deliverable industry-standard LAS files for all point cloud data. NV5 Geospatial's proprietary software was used to perform final statistical analysis of the classes in the LAS files, on a per tile level to verify final classification metrics and full LAS header information.

### 3.5. Hydro-Flattened Breakline Processing

Using heads-up digitization, all Lake-Ponds, Double Line Drains, and Islands are manually collected that are within the project size specification. This includes Lake-Ponds greater than 2 acres in size, Double Line Drains with greater than a 100 foot nominal width, and Islands greater than 1 acre in size within a collected hydro feature. Lidar intensity imagery and bare-earth surface models are used to ensure appropriate and complete collection of these features.

Elevation values are assigned to all collected hydro features via NV5 Geospatial's proprietary software. This software sets Lake-Ponds to an appropriate, single elevation to allow for the generation of hydro-flattened digital elevation models (DEM). Double Line Drain elevations are assigned based on lidar elevations and surrounding terrain feature to ensure all breaklines match the lidar within acceptable tolerances. Some deviation is expected between breakline and lidar elevations due to monotonicity, connectivity, and flattening rules that are enforced on the breaklines. Once complete, horizontal placement, and vertical variances are reviewed, all breaklines are evaluated for topological consistency and data integrity using a combination of proprietary tools and manual review of hydro-flattened DEMs.

Breaklines are combined into one seamless shapefile, clipped to the project boundary, and imported into an Esri file geodatabase for delivery.

### 3.6. Hydro-Flattened Raster DEM Processing

Hydro-Flattened DEMs (topographic) represent a lidar-derived product illustrating the grounded terrain and associated breaklines (as described above) in raster form. NV5 Geospatial’s proprietary software was used to take all input sources (bare earth lidar points, bridge and hydro breaklines, etc.) and create a Triangulated Irregular Network (TIN) on a tile-by-tile basis. Data extending past the tile edge is incorporated in this process so that proper triangulation can occur. From the TIN, linear interpolation is used to calculate the cell values for the raster product. The raster product is then clipped back to the tile edge so that no overlapping cells remain across the project area. A 32-bit floating point GeoTIFF DEM was generated for each tile with a pixel size of 0.5-meter. NV5 Geospatial’s proprietary software was used to write appropriate horizontal and vertical projection information as well as applicable header values into the file during product generation. Each DEM is reviewed in Global Mapper to check for any surface anomalies and to ensure a seamless dataset. NV5 Geospatial ensures there are no void or no-data values (-999999) in each derived DEM. This is achieved by using propriety software checking all cell values that fall within the project boundary. NV5 Geospatial uses a proprietary tool called FOCUS on Delivery to check all formatting requirements of the DEMs against what is required before final delivery.

### 3.7. Intensity Image Processing

Intensity images represent reflectivity values collected by the lidar sensor during acquisition. Proprietary software generates intensity images using first returns and excluding those flagged with a withheld bit. Intensity images are linearly scaled to a value range specific to the project area to standardize the images and reduce differences between individual tiles. Appropriate horizontal projection information as well as applicable header values are written during product generation.

### 3.8. Swath Separation Raster Processing

Swath Separation Images are rasters that represent the interswath alignment between flight lines and provide a qualitative evaluation of the positional quality of the point cloud. NV5 Geospatial proprietary software generated 1-meter raster images in GeoTIFF format using last returns, excluding points flagged with the withheld bit, and using a point-in-cell algorithm. Images are generated with a 75% intensity opacity and (4) absolute 8-cm intervals, see below for interval coloring. Intensity images are linearly scaled to a value range specific to the project area to standardize the images and reduce differences between individual tiles. Appropriate horizontal projection information as well as applicable header values are written to the file during product generation. NV5 Geospatial uses a proprietary tool called FOCUS on Delivery to check all formatting requirements of the images against what is required before final delivery.

	0-8cm
	8-16cm
	16-24cm
	>24cm



### 3.9. Maximum Surface Height Raster Processing

Maximum Surface Height rasters (topographic) represent a lidar-derived product illustrating natural and built-up features. NV5 Geospatial's proprietary software was used to take all first-return classified lidar points, excluding those flagged with a withheld bit, and create a raster on a tile-by-tile basis. Data extending past the tile edge is incorporated in this process so that proper gridding can occur. The raster product is then clipped back to the tile edge so that no overlapping cells remain across the project area. A 32-bit floating point GeoTIFF was generated for each tile with a pixel size of 1-meter. NV5 Geospatial's proprietary software was used to write appropriate horizontal and vertical projection information as well as applicable header values into the file during product generation. Each maximum surface height raster is reviewed in Global Mapper to check for any anomalies and to ensure a seamless dataset. NV5 Geospatial uses a proprietary tool called FOCUS on Delivery to check all formatting requirements of the DEMs against what is required before final delivery.

### 3.10. Contour Processing

Automated routines within TerraScan and TerraModeler generate an educated, thinned subset of bare earth points (ASPRS Class 8, Model Key). Model Key points and hydro-flattened breaklines were used to generate a terrain surface from which 1-foot contours could be generated. Using proprietary software, all tiled contour shapefiles were combined into one, continuous dataset within an Esri File Geodatabase. All lines have their elevations as their attributes and there are no spot elevations or depressions on separate layers.

# MT Statewide Phase4 Delivery 5 Work Unit 300232 Tile Layout

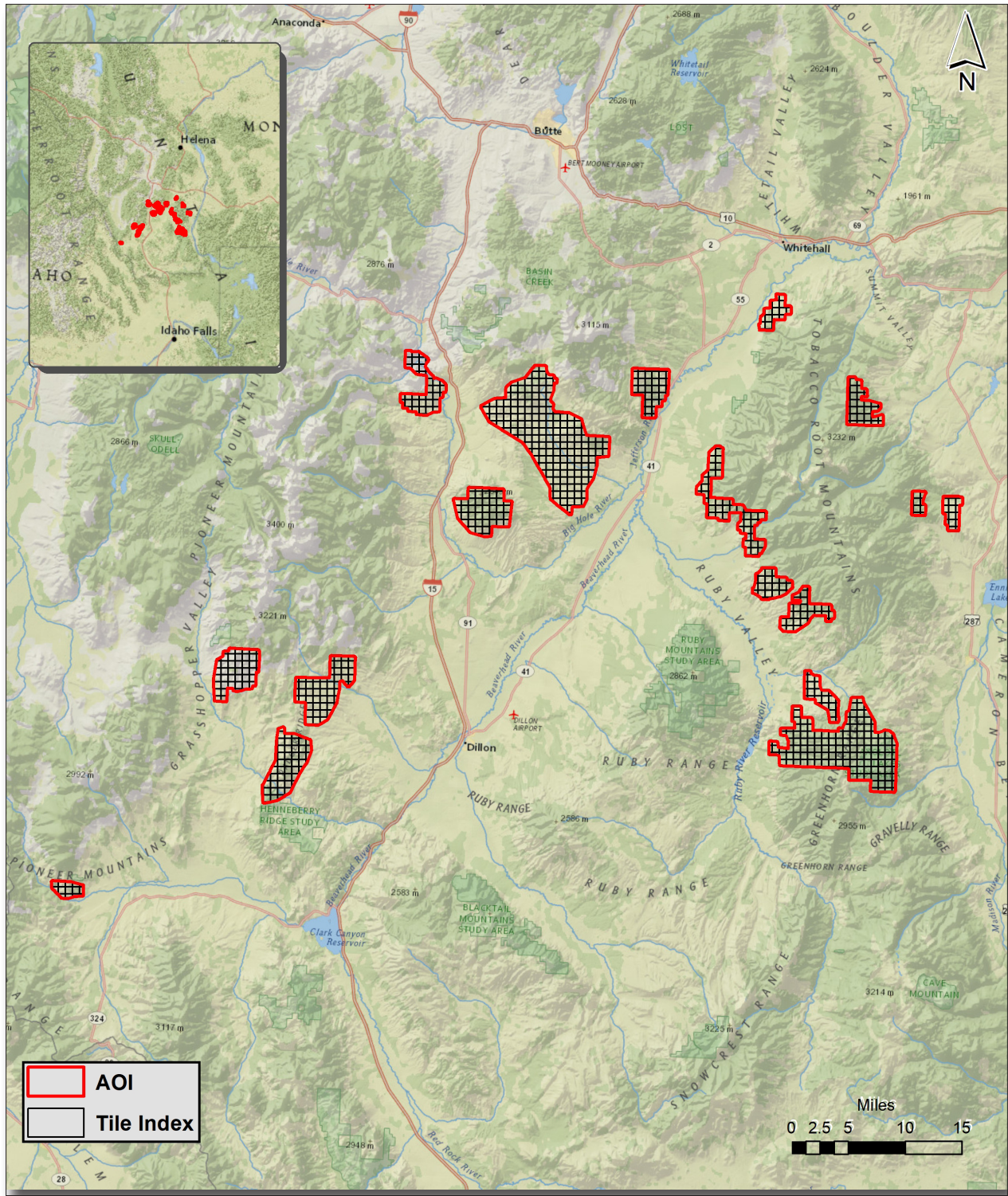


Figure 4. Lidar Tile Layout

# 4. Project Coverage Verification

A proprietary tool (FOCUS on Flight) produces grid-based polygons of each flightline, depicting exactly where lidar points exist. These swath polygons are reviewed against the project boundary to verify adequate project coverage. Please refer to Figure 5.

## MT Statewide Phase4 Delivery 5 Work Unit 300232 Lidar Coverage

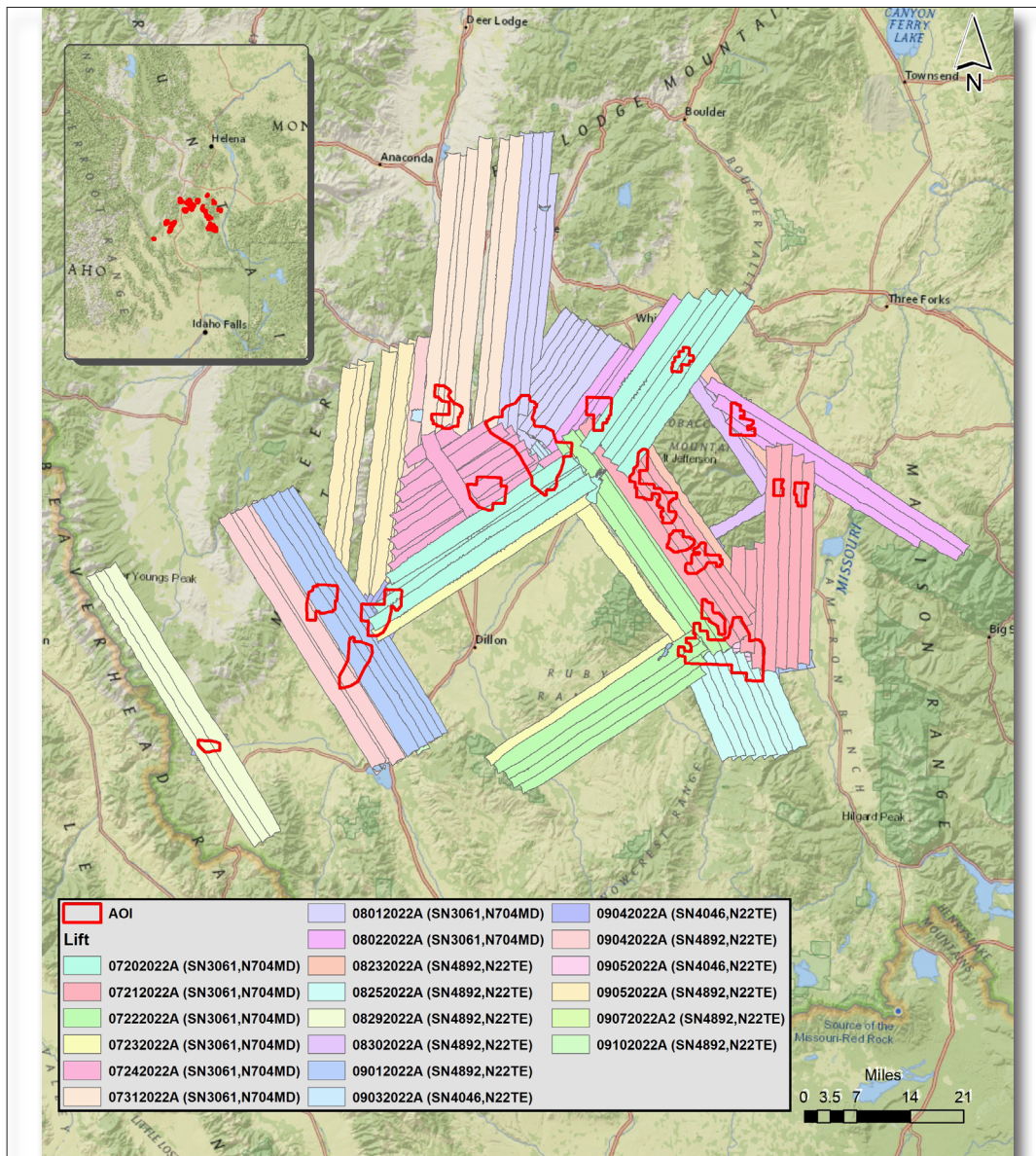


Figure 5. Lidar Coverage

## 6. Geometric Accuracy

### 6.1. Horizontal Accuracy

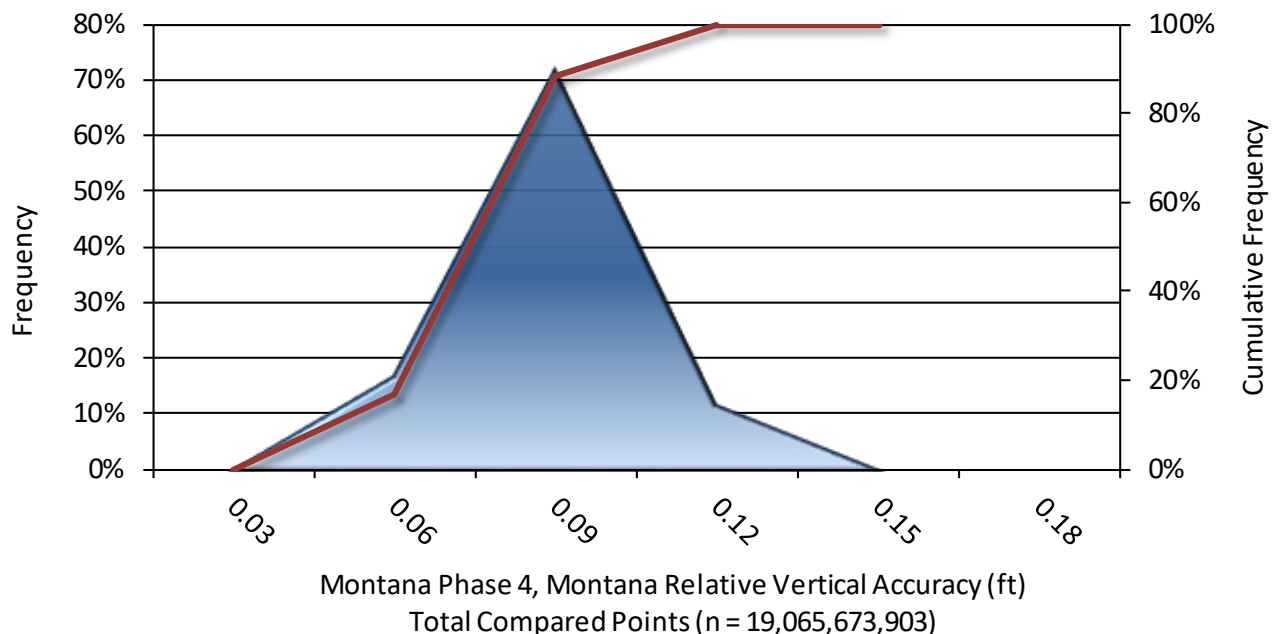
Lidar horizontal accuracy is a function of Global Navigation Satellite System (GNSS) derived positional error, flying altitude, and INS derived attitude error. The obtained  $RMSE_r$  value is multiplied by a conversion factor of 1.7308 to yield the horizontal component of the National Standards for Spatial Data Accuracy (NSSDA) reporting standard where a theoretical point will fall within the obtained radius 95% of the time. Based on a flying altitude of 3050 meters, an IMU error of 0.002 decimal degrees, and a GNSS positional error of 0.015 meters, this project was compiled to meet 0.33 meter horizontal accuracy at the 95% confidence level. A summary is shown below.

Horizontal Accuracy	
$RMSE_r$	0.63 ft
	0.19 m
$ACC_r$	1.09 ft
	0.33 m

## 6.2. Relative Vertical Accuracy

Relative vertical accuracy refers to the internal consistency of the data set as a whole: the ability to place an object in the same location given multiple flight lines, GPS conditions, and aircraft attitudes. When the lidar system is well calibrated, the swath-to-swath vertical divergence is low (<0.10 meters). The relative vertical accuracy was computed by comparing the ground surface model of each individual flight line with its neighbors in overlapping regions. The average (mean) line to line relative vertical accuracy for the MT Statewide Phase4 Delivery 5 project was 0.70 feet (0.021 meters). A summary is shown below.

Relative Vertical Accuracy	
Sample	113 flight line surfaces
Average	0.70 ft
	0.021 m
Median	0.070 ft
	0.021 m
RMSE	0.073 ft
	0.022 m
Standard Deviation (1σ)	0.013 ft
	0.004 m
1.96σ	0.025 ft
	0.008 m



## Project Report Appendices

**The following section contains the appendices as listed in the MT Statewide Phase4 Delivery 5 Lidar Project Report.**

## Appendix A

### Flight Logs

Project	947122-R040220.00	MT_Statewide_Phase4
Flightplan	MT_Statewide4_1560iiS_QL2_200	

Mission Name	S2223061_20220720_F1	Mission Notes
Mission Date	7/20/2022	Half lift for MT Statewide. Significant turbulence today. 704MD flew a half lift to leave some time to get a new secondary radio installed before the crew swap today.
Aircraft	N704MD	
Pilot	Tony Kainz	
Co-Pilot		
Operator	Spencer Beck	
Co-Operator		
Vendor	NV5 Geospatial	
Base Airport	KBZN	
Departure (Local Time)	9:02:00 AM	
Arrival (Local Time)	12:40:00 PM	

Line	Heading	Start Time (UTC)	Stop Time (UTC)	Speed (kt)	Notes
00508	SW	16:12:39	16:23:30	135.6	
00507	NE	16:26:04	16:36:33	138.0	
00506	SW	16:38:48	16:48:57	136.2	Refly area specified in provided shapefile due to density loss from excessive turbulence.
00505	NE	16:50:30	16:59:47	139.8	Refly area specified in provided shapefile due to density loss from excessive turbulence.
00504	SW	17:01:43	17:11:19	132.6	Refly area specified in provided shapefile due to density loss from excessive turbulence.
00673	SW	17:12:33	17:25:16	118.5	Refly area specified in provided shapefile due to density loss from excessive turbulence.
00674	NE	17:27:34	17:39:09	135.4	Refly area specified in provided shapefile due to density loss from excessive turbulence.
00675	SW	17:41:45	17:54:52	129.8	Refly area specified in provided shapefile due to density loss from excessive turbulence.
00676	NE	17:57:01	18:10:10	136.7	Refly area specified in provided shapefile due to density loss from excessive turbulence.



Project	947122-R040220.00	MT_Statewide_Phase4
Flightplan	MT_Statewide4_1560iiS_QL2_200	

Mission Name	S2223061_20220721_F1	Mission Notes
Mission Date	7/21/2022	Great day of wide area acq, with no issues to note.
Aircraft	N704MD	
Pilot	Creston Saul	
Co-Pilot		
Operator	Stephanie Cohee	
Co-Operator		
Vendor	NV5 Geospatial	
Base Airport	KBZN	
Departure (Local Time)	8:46:00 AM	
Arrival (Local Time)	1:59:00 PM	

Line	Heading	Start Time (UTC)	Stop Time (UTC)	Speed (kt)	Notes
00223	S	15:12:04	15:20:05	142.7	
00222	N	15:23:02	15:31:37	140.1	
00221	N	15:31:44	15:31:49	148.1	mis-fire on N end of line "Line221" 153144
00221	S	15:34:26	15:42:49	146.4	snow on N end of line. refl
00211	N	15:51:37	15:59:39	136.9	
00212	S	16:03:02	16:12:45	144.9	
00210	N	16:17:50	16:26:14	136.4	
00209	S	16:28:47	16:36:55	146.3	
00208	N	16:40:22	16:49:22	137.5	
00207	S	16:52:49	17:01:33	147.9	
00206	N	17:04:17	17:14:12	138.6	
00205	S	17:17:02	17:26:55	147.4	
00204	N	17:30:19	17:41:26	137.3	
00203	S	17:43:44	17:54:24	143.6	
00202	N	17:57:24	18:03:25	142.2	
00201	S	18:06:06	18:11:03	141.2	
00200	N	18:13:16	18:17:43	140.2	
00520	NW	18:22:20	18:32:20	127.3	snow mid-line. refl
00515	SE	18:35:39	18:44:28	154.9	
00514	NW	18:48:05	19:01:58	125.1	
00513	SE	19:04:39	19:16:38	151.2	
00512	NW	19:19:13	19:33:27	128.6	
00512	NE	19:35:58	19:38:08	167.4	

Project	947122-R040220.00	MT_Statewide_Phase4
Flightplan	MT_Statewide4_1560iiS_QL2_200	

Mission Name	S2223061_20220722_F1	Mission Notes
Mission Date	7/22/2022	The flight was smooth with no issues until moderate turbulence in the afternoon.
Aircraft	N704MD	
Pilot	Creston Saul	
Co-Pilot		
Operator	Stephanie Cohee	
Co-Operator		
Vendor	NV5 Geospatial	
Base Airport	KBZN	
Departure (Local Time)	8:36:00 AM	
Arrival (Local Time)	12:58:00 PM	

Line	Heading	Start Time (UTC)	Stop Time (UTC)	Speed (kt)	Notes
00511	SE	15:06:44	15:19:49	139.5	
00510	NW	15:23:15	15:36:28	137.2	
00509	SE	15:39:08	15:52:03	136.5	
00705	SW	15:57:57	16:08:05	127.0	
00704	NE	16:10:30	16:19:31	143.5	
00703	SW	16:22:47	16:32:24	135.5	
00702	NE	16:34:39	16:44:04	140.8	
00701	SW	16:46:54	16:56:55	136.6	
00700	NE	16:59:12	17:08:54	144.8	
00699	SW	17:12:25	17:23:06	135.1	
00698	NE	17:26:10	17:36:18	146.1	
00697	SW	17:39:39	17:50:56	138.6	
00696	NE	17:53:16	18:04:16	147.3	
00695	SW	18:07:37	18:18:59	143.7	Turb N end of line.xline182244 Record015
00694	SE	18:22:44	18:28:06	158.7	xline182244

Project	947122-R040220.00	MT_Statewide_Phase4
Flightplan	MT_Statewide4_1560iis_QL2_200	

Mission Name	S2223061_20220723_F1	Mission Notes
Mission Date	7/23/2022	Data reader did not boot up on initial start, did a full reboot before getting online. This was the beginning of line 694 on E end of the line. We diverted once to scope out a potential wildfire start and reported to ATC. Normal flight otherwise with minimal turb in afternoon.
Aircraft	N704MD	
Pilot	Creston Saul	
Co-Pilot		
Operator	Stephanie Cohee	
Co-Operator		
Vendor	NV5 Geospatial	
Base Airport	KBZN	
Departure (Local Time)	8:09:00 AM	
Arrival (Local Time)	2:23:00 PM	

Line	Heading	Start Time (UTC)	Stop Time (UTC)	Speed (kt)	Notes
00694	SW	14:33:21	14:33:21		data recorder bad start. reboot
00694	SW	14:56:47	15:08:30	141.0	this is the refly line
00693	NE	15:11:02	15:22:44	141.9	
00692	SW	15:26:02	15:37:54	141.1	
00691	NE	15:40:14	15:52:23	139.1	
00690	SW	15:55:38	16:07:34	142.8	
00689	NE	16:09:24	16:21:52	141.4	
00688	SW	16:25:03	16:37:59	143.2	
00687	NE	16:39:48	16:53:01	139.9	
00696	SW	17:09:08	17:10:04	137.5	
00686	SW	17:16:37	17:29:43	141.1	
00685	NE	17:32:29	17:45:38	140.4	
00684	SW	17:48:21	18:01:12	143.7	
00683	NE	18:03:37	18:16:24	144.2	
00682	SW	18:18:59	18:31:47	143.8	
00681	NE	18:34:25	18:47:15	142.5	
00680	SW	18:49:37	19:02:34	141.3	
00679	NE	19:05:15	19:17:59	144.0	
00678	SW	19:20:49	19:33:47	140.8	
00677	NE	19:35:37	19:48:04	146.8	xline. 021. 195208
00676	SE	19:52:08	20:00:46	163.7	

Project	947122-R040220.00	MT_Statewide_Phase4
Flightplan	MT_Statewide4_1560iis_QL2_200	

Mission Name	S2223061_20220724_F1	Mission Notes
Mission Date	7/24/2022	another early lift to beat the afternoon weather around the mountains. Local wildfire smoke and thunderstorms in the afternoon, but still had good returns.
Aircraft	N704MD	
Pilot	Creston Saul	
Co-Pilot		
Operator	Stephanie Cohee	
Co-Operator		
Vendor	NV5 Geospatial	
Base Airport	KBZN	
Departure (Local Time)	8:05:00 AM	
Arrival (Local Time)	1:10:00 PM	

Line	Heading	Start Time (UTC)	Stop Time (UTC)	Speed (kt)	Notes
00672	SW	14:41:15	14:51:50	137.6	
00671	NE	14:53:38	15:01:50	145.3	
00670	SW	15:04:44	15:13:06	132.7	
00669	NE	15:14:36	15:22:04	142.1	
00668	SW	15:24:15	15:31:42	135.7	
00667	NE	15:33:11	15:39:42	144.8	
00666	SW	15:42:06	15:48:20	137.7	
00665	NE	15:49:51	15:54:45	144.1	
00664	SW	15:56:59	16:00:55	135.4	
00663	NE	16:02:32	16:05:19	139.5	XLINE 160757. 011
00664	SE	16:07:57	16:12:54	145.9	XLINE
00400	SE	16:24:14	16:25:56	137.5	
00400	SE	16:32:02	16:45:04	139.1	162414S lost postrack N end, refly163202S
00399	NW	16:47:26	17:00:18	140.8	
00398	SE	17:02:31	17:15:30	139.8	
00397	NW	17:17:39	17:30:52	137.8	
00396	SE	17:32:59	17:45:45	142.5	
00395	NW	17:47:47	18:00:49	139.7	
00394	SE	18:02:37	18:15:19	143.7	
00393	NW	18:17:18	18:29:47	146.2	
00392	E	18:32:54	18:36:52	175.2	

Project	947122-R040220.00	MT_Statewide_Phase4
Flightplan	MT_Statewide4_1560iis_QL2_200	

Mission Name	S2223061_20220731_F1	Mission Notes
Mission Date	7/31/2022	Mobed to south AOI from KMSO and started on a block south of Butte, MT. There was heavy smoke from local wildfires on the south half of the line, but the returns were still good. We eventually ran into heavy turbulence on that block and then moved to a block located right over Butte and finished that block. Good day of acq.
Aircraft	N704MD	
Pilot	Creston Saul	
Co-Pilot		
Operator	Stephanie Cohee	
Co-Operator		
Vendor	NV5 Geospatial	
Base Airport	KBZN	
Departure (Local Time)	7:50:00 AM	
Arrival (Local Time)	1:05:00 PM	

Line	Heading	Start Time (UTC)	Stop Time (UTC)	Speed (kt)	Notes
00478	S	14:24:13	14:40:05	129.4	heavy smoke on south half of lines
00479	N	14:42:26	14:58:01	131.6	
00480	S	15:00:44	15:16:05	133.7	
00481	N	15:18:13	15:34:26	128.0	
00482	S	15:37:23	15:53:51	131.2	
00483	N	15:56:10	16:13:09	127.0	
00484	S	16:15:40	16:31:11	138.1	
00485	N	16:34:23	16:51:54	122.6	Refly 15-20 statute miles FNE due to density loss from turbulence. heavy turb on midline to north end
00541	N	16:59:49	17:07:52	123.8	
00542	S	17:10:16	17:17:40	134.6	
00543	N	17:19:35	17:27:04	129.3	
00544	S	17:29:13	17:35:59	137.6	
00545	N	17:37:59	17:44:58	124.7	
00546	S	17:46:35	17:52:34	127.9	
00547	N	17:54:19	18:00:07	124.4	
00548	S	18:02:34	18:06:29	130.8	
00549	N	18:08:20	18:11:54	125.5	moderate turbulence
00550	S	18:14:19	18:17:28	129.8	
00551	N	18:19:05	18:21:50	128.2	
00552	S	18:23:51	18:25:52	140.3	
00553	SW	18:29:54	18:37:39	122.9	xline 182954W record021

Project	947122-R040220.00	MT_Statewide_Phase4
Flightplan	MT_Statewide4_1560iiS_QL2_200	

Mission Name	S2223061_20220801_F1	Mission Notes
Mission Date	8/1/2022	The usual conditions today. Wind starting up around 11:30 then turbulence then clouds around 12.
Aircraft	N704MD	
Pilot	Creston Saul	
Co-Pilot		
Operator	Stephanie Cohee	
Co-Operator		
Vendor	NV5 Geospatial	
Base Airport	KBZN	
Departure (Local Time)	8:40:00 AM	
Arrival (Local Time)	12:35:00 PM	

Line	Heading	Start Time (UTC)	Stop Time (UTC)	Speed (kt)	Notes
00486	N	15:16:58	15:33:40	129.5	
00487	S	15:36:05	15:52:01	136.7	
00488	N	15:55:32	16:11:11	124.2	
00489	S	16:14:33	16:25:57	136.2	
00490	N	16:30:00	16:39:22	128.6	
00491	S	16:42:28	16:49:19	133.2	
00492	N	16:51:19	16:56:53	126.9	
00493	S	17:01:04	17:02:45	136.0	
00495	S	17:02:56	17:03:04	150.2	misfire at start. reflw
00494	SW	17:06:30	17:11:40	135.0	
00495	NE	17:13:48	17:19:11	133.2	
00496	SW	17:21:22	17:26:53	131.5	
00497	NE	17:27:29	17:35:26	134.7	misfire at start. record013
00498	SW	17:37:36	17:44:32	123.3	
00499	NE	17:46:18	17:52:33	136.8	
00500	SW	17:54:55	18:01:25	133.3	heavy turb midline. xline 189521 record017
00501	NW	18:05:21	18:10:49	121.3	

Project	947122-R040220.00	MT_Statewide_Phase4
Flightplan	MT_Statewide4_1560iiS_QL2_200	

Mission Name	S2223061_20220802_F1	Mission Notes
Mission Date	8/2/2022	Poor weather conditions today. We flew what we could that was cloud and snow free. Attempted north block near Helena, but down drafts, turbulence and clouds kick us out.
Aircraft	N704MD	
Pilot	Creston Saul	
Co-Pilot		
Operator	Stephanie Cohee	
Co-Operator		
Vendor	NV5 Geospatial	
Base Airport	KBZN	
Departure (Local Time)	8:32:00 AM	
Arrival (Local Time)	12:08:00 PM	

Line	Heading	Start Time (UTC)	Stop Time (UTC)	Speed (kt)	Notes
00501	SW	15:02:18	15:09:20	125.1	
00502	NE	15:12:04	15:17:47	154.6	
00502	SW	15:21:16	15:28:41	118.7	refly. too fast
00503	NE	15:30:46	15:40:05	140.8	
00538	SE	15:48:45	16:04:09	136.5	
00539	NW	16:06:51	16:24:06	114.8	
00540	SE	16:26:00	16:37:21	138.0	
00541	NE	16:41:45	16:43:56	151.2	xline 164145 E record08
00642	N	17:28:17	17:32:55	95.5	slow due to heavy down draft. turb. aborted. refly

Project	947122-R040220.00	MT_Statewide_Phase4
Flightplan	MT_Statewide4_1560iiS_QL2_200	

Mission Name	SN4892_20220823_F1	Mission Notes
Mission Date	8/23/2022	
Aircraft	N22TE	
Pilot	Ethan Hillmer	
Co-Pilot		
Operator	Joel Riggs	
Co-Operator		
Vendor	NV5 Geospatial	
Base Airport	KBMT	
Departure (Local Time)	8:19:00 AM	
Arrival (Local Time)	12:00:00 PM	

Line	Heading	Start Time (UTC)	Stop Time (UTC)	Speed (kt)	Notes
00649	SW	14:42:23	14:46:30	132.9	
00459	S	15:06:03	15:09:02	132.7	
00460	SW	15:09:57	15:10:02	133.0	
00460	N	15:13:32	15:17:31	136.1	
00461	S	15:22:47	15:27:55	134.9	
00462	N	15:31:20	15:37:31	133.7	
00463	S	15:41:37	15:48:46	135.6	
00464	N	15:53:07	16:01:25	135.7	
00465	S	16:07:17	16:16:41	134.6	
00466	N	16:21:15	16:31:33	133.2	
00516	SE	17:03:47	17:12:16	138.7	
00523	NW	17:18:58	17:20:06	135.6	Aborted / Misfire
00528	NW	17:27:34	17:35:19	133.4	



Project	947122-R040220.00	MT_Statewide_Phase4
Flightplan	MT_Statewide4_1560iiS_QL2_200	

Mission Name	SN4892_20220825_F1	Mission Notes
Mission Date	8/25/2022	One lift today.
Aircraft	N22TE	
Pilot	Ethan Hillmer	
Co-Pilot		
Operator	Steve Krohn	
Co-Operator		
Vendor	NV5 Geospatial	
Base Airport	KBMT	
Departure (Local Time)	7:59:00 AM	
Arrival (Local Time)	1:23:00 PM	

Line	Heading	Start Time (UTC)	Stop Time (UTC)	Speed (kt)	Notes
00517	SE	14:27:16	14:35:17	137.1	
00521	NW	14:39:33	14:50:01	124.8	
00520	SE	14:53:15	15:02:24	137.7	Reflight
00439	S	15:09:11	15:12:33	133.8	
00451	NW	15:17:03	15:22:54	131.0	
00452	SE	15:26:14	15:32:05	134.2	
00453	NW	15:36:39	15:42:34	131.7	
00454	SE	15:45:37	15:51:24	135.8	
00455	NW	15:56:01	16:01:50	133.3	
00456	SE	16:05:45	16:11:24	135.4	
00457	NW	16:15:22	16:20:39	128.1	
00458	SE	16:24:19	16:28:46	132.0	
00408	SW	16:33:03	16:39:33	123.7	
00409	SW	16:40:08	16:40:13	127.5	accidental start/stop
00409	E	16:43:58	16:50:34	137.0	
00410	SW	16:54:35	17:03:03	117.8	
00411	E	17:06:38	17:14:41	136.7	
00412	SW	17:18:17	17:28:50	113.7	
00413	E	17:32:22	17:41:52	135.9	
00414	SW	17:46:14	17:57:46	120.0	
00415	E	18:01:33	18:12:23	137.4	
00416	SW	18:16:43	18:29:53	120.1	
00417	E	18:34:19	18:46:29	138.4	Due to tail wind, can't go any slower than 142 k

Project	947122-R040220.00	MT_Statewide_Phase4
Flightplan	MT_Statewide4_1560iis_QL2_200	

Mission Name	SN4892_20220829_F1	Mission Notes
Mission Date	8/29/2022	One lift today in excellent conditions, followed by a MOB to Bozeman.
Aircraft	N22TE	
Pilot	Ethan Hillmer	
Co-Pilot	Tyler Ledeboer	
Operator	Steve Krohn	
Co-Operator		
Vendor	NV5 Geospatial	
Base Airport	KBZN	
Departure (Local Time)	7:38:00 AM	
Arrival (Local Time)	2:04:00 PM	

Line	Heading	Start Time (UTC)	Stop Time (UTC)	Speed (kt)	Notes
00304	NW	14:27:46	14:28:14	116.9	Test start/stop
00304	SE	14:33:01	14:38:02	129.3	
00303	NW	14:41:51	14:44:23	131.2	
00306	NW	14:50:53	15:03:43	129.0	
00305	SE	15:06:46	15:18:00	125.5	
00334	SE	15:24:20	15:40:33	129.4	
00333	NW	15:44:20	15:56:01	128.7	
00332	SE	16:03:00	16:09:29	130.7	
00331	NW	16:13:31	16:20:14	125.6	
00330	SE	16:23:15	16:29:41	129.8	
00329	NW	16:33:23	16:37:07	133.5	
00335	NW	16:44:56	17:01:56	127.3	
00336	SE	17:04:19	17:21:02	129.6	
00337	NW	17:23:41	17:40:30	128.6	
00338	SE	17:49:34	18:06:04	130.7	
00339	NW	18:07:37	18:24:23	128.1	
00340	SE	18:26:21	18:43:24	125.6	
00341	NW	18:46:10	19:02:35	130.1	
00342	SE	19:05:52	19:22:26	128.4	

Project	947122-R040220.00	MT_Statewide_Phase4
Flightplan	MT_Statewide4_1560iis_QL2_200	

Mission Name	SN4892_20220830_F1	Mission Notes
Mission Date	8/30/2022	One lift today, smooth in the morning, some turbulence in the afternoon, visibility excellent.
Aircraft	N22TE	
Pilot	Ethan Hillmer	
Co-Pilot	Tyler Ledeboer	
Operator	Steve Krohn	
Co-Operator		
Vendor	NV5 Geospatial	
Base Airport	KBZN	
Departure (Local Time)	7:42:00 AM	
Arrival (Local Time)	1:47:00 PM	

Line	Heading	Start Time (UTC)	Stop Time (UTC)	Speed (kt)	Notes
00527	NW	14:26:58	14:35:43	126.0	
00526	SE	14:37:43	14:46:53	127.0	
00525	NW	14:49:32	14:59:05	127.0	
00524	SE	15:01:58	15:11:26	129.9	
00523	NW	15:14:27	15:24:42	124.0	
00522	SE	15:26:31	15:37:11	124.0	
00519	NW	15:40:05	15:49:46	124.8	
00518	SE	15:52:32	16:01:51	124.1	
x-tie	NE	16:07:12	16:12:16	125.6	X-tie
00213	S	16:17:08	16:28:10	125.9	
00214	N	16:30:55	16:41:35	127.5	
00215	S	16:43:58	16:54:25	128.7	
00216	N	16:56:53	17:06:55	131.9	
00217	S	17:09:16	17:19:41	125.8	
00218	N	17:21:42	17:31:41	128.4	
00219	S	17:34:05	17:44:09	125.3	
00220	N	17:46:31	17:56:02	129.7	Refly 0-8 statute miles FSE due to excessive turbulence
00221	S	17:58:08	18:07:43	126.5	
x-tie	NW	18:11:40	18:18:53	128.5	
00450	S	18:21:06	18:32:36	129.9	
00449	N	18:34:32	18:46:23	129.9	
00448	S	18:49:03	19:01:14	131.3	
00447	N	19:03:44	19:16:09	132.6	Refly 6.5-28 statute miles FSE due to excessive turbulence
x-tie	E	19:18:29	19:21:21	132.2	

Project	947122-R040220.00	MT_Statewide_Phase4
Flightplan	MT_Statewide4_1560iis_QL2_200	

Mission Name	SN4892_20220901_F1	Mission Notes
Mission Date	9/1/2022	One lift today until turbulence became too heavy.
Aircraft	N22TE	
Pilot	Mikhail Dekanu	
Co-Pilot		
Operator	Steve Krohn	
Co-Operator		
Vendor	NV5 Geospatial	
Base Airport	KBZN	
Departure (Local Time)	9:07:00 AM	
Arrival (Local Time)	1:53:00 PM	

Line	Heading	Start Time (UTC)	Stop Time (UTC)	Speed (kt)	Notes
00443	S	15:43:05	15:53:11	127.5	
00442	N	15:56:48	16:05:21	127.5	
00441	S	16:08:17	16:15:09	128.4	
00440	N	16:19:06	16:24:26	126.9	
X-tie	E	16:26:55	16:29:06	160.2	X-tie
00418	SW	16:40:02	16:54:29	123.3	
00419	E	16:57:49	17:11:57	133.1	Turbulence
00420	SW	17:15:32	17:31:40	118.0	Turbulence
00361	NW	17:40:43	17:56:22	126.9	
00360	SE	17:59:15	18:14:43	128.6	
00359	NW	18:17:49	18:33:45	125.7	
00358	SE	18:38:01	18:53:30	129.8	Refly 5.5-10 statute miles FSE due to excessive turbulence
00357	NW	18:56:15	19:12:28	124.4	Refly 7.5-18.5 statute miles FSE due to excessive turbulence
X-tie	NE	19:15:24	19:17:57	164.3	X-tie

Project	947122-R040220.00	MT_Statewide_Phase4
Flightplan	MT_Statewide4_1560iis_QL1	

Mission Name	S2224046_20220903_F1	Mission Notes
Mission Date	9/3/2022	
Aircraft	N840JA	
Pilot	Robert Cale	
Co-Pilot		
Operator	Erin Guillory	
Co-Operator		
Vendor	NV5 Geospatial	
Base Airport	KBZN	
Departure (Local Time)	8:08:00 AM	
Arrival (Local Time)	2:21:00 PM	

Line	Heading	Start Time (UTC)	Stop Time (UTC)	Speed (kt)	Notes
00053	SW	14:26:47	14:29:21	125.2	
00054	E	14:32:19	14:34:54	125.9	
00055	SW	14:38:43	14:39:47	125.3	
00055	E	14:44:09	14:46:36	126.9	
00056	SW	14:50:12	14:52:43	125.8	
00057	E	14:55:09	14:57:39	125.1	
00058	SW	15:00:34	15:01:44	125.0	
00059	E	15:04:24	15:04:52	129.3	
00066	N	15:09:56	15:11:30	125.0	
00065	S	15:14:22	15:15:52	134.3	
00064	N	15:18:30	15:20:26	145.0	
00063	S	15:23:04	15:25:06	146.1	
00062	N	15:27:37	15:29:42	145.8	
00061	S	15:31:59	15:34:05	143.1	
00060	N	15:36:25	15:38:19	143.7	
00101	SW	15:42:44	15:44:02	146.1	
00100	NE	15:46:26	15:48:06	145.5	
00099	SW	15:50:55	15:52:49	146.1	
00098	NE	15:55:14	15:57:09	145.8	
00097	SW	15:59:37	16:01:09	146.0	
00073	S	16:04:19	16:05:51	147.1	
00072	N	16:08:45	16:10:48	147.0	
00071	S	16:13:00	16:15:11	145.3	
00070	N	16:17:34	16:19:44	144.9	
00069	S	16:22:01	16:24:09	145.3	
00068	N	16:26:49	16:28:15	145.3	
00067	S	16:30:50	16:32:13	145.6	
00088	NW	16:33:43	16:33:51	142.9	
00088	SE	16:35:36	16:36:08	146.8	
00087	NW	16:38:43	16:42:26	146.2	
00086	SE	16:44:40	16:48:46	145.8	
00085	NW	16:50:49	16:55:04	145.8	
00084	SE	16:56:58	17:01:05	146.5	
00083	NW	17:03:20	17:07:34	146.4	
00082	SE	17:09:46	17:10:02	143.5	
00082	SE	17:26:07	17:30:32	145.7	
00081	NW	17:33:13	17:37:47	146.2	
00080	SE	17:39:48	17:44:27	145.9	
00079	NW	17:47:01	17:51:53	145.7	
00078	SE	17:53:58	17:58:52	145.1	
00077	NW	18:01:00	18:06:00	145.8	
00076	SE	18:08:07	18:13:06	145.6	
00075	NW	18:15:09	18:20:12	147.2	
00074	SE	18:22:05	18:26:53	144.7	
00052	SW	18:29:50	18:30:48	147.4	
00051	E	18:33:06	18:34:27	144.4	
00050	SW	18:36:54	18:38:57	145.1	
00049	E	18:41:06	18:43:18	146.7	
00048	SW	18:45:29	18:47:46	146.2	
00047	E	18:50:06	18:52:27	145.4	
00046	SW	18:54:28	18:56:49	146.9	
00045	E	18:58:59	19:01:21	144.1	

00044	SW	19:03:36	19:05:17	147.1
00043	E	19:07:28	19:09:06	143.8
00096	N	19:16:46	19:18:13	145.7
00095	S	19:20:13	19:21:54	145.4
00094	N	19:24:06	19:26:01	145.4
00093	S	19:28:25	19:30:51	145.8
00092	N	19:33:14	19:35:50	144.7
00091	S	19:37:32	19:40:07	144.3
00090	N	19:42:12	19:44:36	146.8
00089	S	19:46:56	19:49:12	142.9

Project	947122-R040220.00	MT_Statewide_Phase4
Flightplan	MT_Statewide4_1560iis_QL1	

Mission Name	S2224046_20220904_F1	Mission Notes
Mission Date	9/4/2022	Collected on the West end of QL1, and worked back East until out of O2.
Aircraft	N840JA	
Pilot	Robert Cale	
Co-Pilot		
Operator	Erin Guillory	
Co-Operator		
Vendor	NV5 Geospatial	
Base Airport	KBZN	
Departure (Local Time)	8:09:00 AM	
Arrival (Local Time)	1:09:00 PM	

Line	Heading	Start Time (UTC)	Stop Time (UTC)	Speed (kt)	Notes
00001	SW	15:00:47	15:02:38	125.6	
00002	E	15:05:48	15:07:27	146.1	
00003	SW	15:10:49	15:12:33	130.2	
00004	E	15:14:56	15:15:57	144.8	
00035	N	15:22:45	15:24:41	143.1	
00036	S	15:27:11	15:29:23	145.4	
00037	N	15:31:38	15:33:57	145.1	
00038	S	15:37:14	15:39:26	145.2	
00039	N	15:41:48	15:43:46	145.6	
00040	S	15:46:28	15:48:22	145.8	
00041	N	15:50:58	15:52:48	146.3	
00042	S	15:55:36	15:57:11	143.4	
00005	NE	15:58:53	15:59:45	142.8	
00006	SW	16:02:28	16:04:56	145.5	
00007	NE	16:07:39	16:10:39	147.7	
00008	SW	16:13:52	16:19:08	143.9	
00009	NE	16:21:42	16:27:20	146.9	
00010	SW	16:30:14	16:36:10	146.2	
00011	NE	16:38:44	16:44:42	147.0	
00012	SW	16:47:18	16:53:08	142.3	
00013	NE	16:55:40	17:00:39	145.1	
00102	SE	17:11:51	17:14:03	147.3	
00103	NW	17:16:41	17:22:36	144.6	
00104	SE	17:25:08	17:31:19	145.2	
00105	NW	17:33:39	17:39:57	144.0	
00106	SE	17:42:19	17:48:36	146.0	
00107	NW	17:51:23	17:57:44	146.0	
00108	SE	18:00:37	18:07:12	145.7	
00109	NW	18:09:31	18:16:34	145.8	
00110	SE	18:18:58	18:26:03	146.5	
00111	NW	18:28:30	18:35:35	145.7	
00112	SE	18:38:06	18:44:48	148.4	

Project	947122-R040220.00	MT_Statewide_Phase4
Flightplan	MT_Statewide4_1560iiS_QL1	

Mission Name	S2224046_20220905_F1	Mission Notes
Mission Date	9/5/2022	Completed MT QL1 today. Thump in the engine, returned to BZN for Mx to take a look.
Aircraft	N840JA	
Pilot	Robert Cale	
Co-Pilot		
Operator	Erin Guillory	
Co-Operator		
Vendor	NV5 Geospatial	
Base Airport	KBZN	
Departure (Local Time)	10:05:00 AM	
Arrival (Local Time)	12:52:00 PM	

Line	Heading	Start Time (UTC)	Stop Time (UTC)	Speed (kt)	Notes
00014	SW	16:31:34	16:32:27	136.8	
00015	E	16:34:32	16:35:40	146.8	
00016	SW	16:38:28	16:39:52	131.5	
00017	E	16:41:43	16:44:06	147.8	
00018	SW	16:47:19	16:50:01	134.6	
00019	E	16:52:12	16:55:11	145.9	
00020	SW	16:57:56	17:01:15	136.8	
00021	E	17:02:57	17:06:14	143.5	
00022	SW	17:08:52	17:13:11	134.9	
00023	E	17:14:58	17:19:03	150.6	
00024	SW	17:21:19	17:21:48	147.5	
00024	SW	17:24:59	17:29:41	137.9	
00025	E	17:31:24	17:34:26	151.3	
00025	SW	17:38:02	17:39:43	143.4	
00026	E	17:41:45	17:41:50	207.0	
00026	SW	17:43:37	17:48:23	139.3	
00027	E	17:50:05	17:54:30	150.3	
00028	SW	17:57:09	18:01:53	137.4	
00029	E	18:03:33	18:07:37	149.6	
00030	SW	18:12:12	18:16:27	139.4	
00031	E	18:19:22	18:21:17	150.4	
00032	SW	18:23:48	18:25:54	136.8	
00033	E	18:27:28	18:28:45	153.5	
00034	SW	18:31:17	18:32:38	136.9	



Project	947122-R040220.00	MT_Statewide_Phase4
Flightplan	MT_Statewide4_1560iis_QL2_200	

Mission Name	SN4892_20220905_F1	Mission Notes
Mission Date	9/5/2022	On lift today. Very smokey conditions to the east of the AOI. Better in the western parts. Due to very strong E-W winds (50-60k ), along with heavy turbulence, were unable to complete the northern block of E-W lines today. Hopefully conditions will improve tomorrow.
Aircraft	N22TE	
Pilot	Mikhail Dekanu	
Co-Pilot		
Operator	Steve Krohn	
Co-Operator		
Vendor	NV5 Geospatial	
Base Airport	KBZN	
Departure (Local Time)	7:50:00 AM	
Arrival (Local Time)	12:27:00 PM	

Line	Heading	Start Time (UTC)	Stop Time (UTC)	Speed (kt)	Notes
00505	SW	14:22:52	14:33:41	118.4	Reflight
00675	SW	14:35:52	14:51:15	109.7	Reflight
00475	N	14:55:11	15:00:24	127.5	Scanner stopped mid-line
00475	N	15:14:33	15:29:16	128.5	
00474	S	15:32:24	15:47:47	121.2	
00473	N	15:50:52	16:05:23	126.1	
00472	S	16:08:30	16:23:54	116.5	
00471	N	16:27:16	16:41:47	119.7	
00470	S	16:44:32	16:59:31	112.6	
00469	N	17:02:11	17:16:06	117.7	
00468	S	17:18:57	17:32:38	115.5	
00467	N	17:35:03	17:46:41	127.9	
00662	NE	17:53:38	18:00:44	141.9	Attempted to fly this line, however tail winds too high

Project	947122-R040220.00	MT_Statewide_Phase4
Flightplan	MT_Statewide4_1560iis_QL2_200	

Mission Name	SN4892_20220907_F1	Mission Notes
Mission Date	9/7/2022	Basically a clean-up day with one lift. Completed all the regular lines, and the remaining QL-2 normal reflights. However we tried a long and a short line in the REFLY MDB prepared especially for lines 530-537, but were unable due to increasing turbulence, as it looked like strong winds out of the west were passing over a ridge very close to that AOI.
Aircraft	N22TE	
Pilot	Mikhail Dekanu	
Co-Pilot		
Operator	Steve Krohn	
Co-Operator		
Vendor	NV5 Geospatial	
Base Airport	KBZN	
Departure (Local Time)	7:49:00 AM	
Arrival (Local Time)	12:27:00 PM	

Line	Heading	Start Time (UTC)	Stop Time (UTC)	Speed (kt)	Notes
00650	SW	14:33:37	14:51:56	104.0	
00649	SW	15:10:53	15:26:45	112.7	Refly remainder to cover AOI
00485	S	15:44:45	15:54:46	121.6	Reflew 0-20 FNE
00500	SW	16:01:13	16:07:05	115.7	Reflew 0-11 FNE
00673	SW	16:10:28	16:23:32	114.4	Reflew all
00674	NE	16:27:45	16:39:39	130.9	Reflew all
00504	NE	16:40:44	16:40:58	147.1	Offline, reflew
00504	NE	16:45:49	16:52:47	132.0	Reflew 0-15 FSE
00447	S	17:10:48	17:23:44	127.3	Reflew all
00220	N	17:33:24	17:37:17	129.4	Reflew 0-8 FSE
00532	NW	17:45:17	18:01:42	124.5	Attempted line but several turbulent area- REFLYs
00530	SE	18:06:00	18:07:40	124.3	Turbulence - REFLY

Project	947122-R040220.00	MT_Statewide_Phase4
Flightplan	MT_Statewide4_1560iiS_QL2_200	

Mission Name	SN4892_20220910_F1	Mission Notes
Mission Date	9/10/2022	After taking off from KBZN, crew of N22TE acquired remainder of reflight lines of R040220 MT QL2 AOI on Saturday, 9/10 during a single lift utilizing Riegl 1560ii-S/SN4892. Repositioned to KRDD after refueling at KDLN. Hobbs end and landing time are for arrival at KRDD.
Aircraft	N22TE	
Pilot	Mikhail Dekanu	
Co-Pilot		
Operator	Gary Tao	
Co-Operator		
Vendor	NV5 Geospatial	
Base Airport	KBZN	
Departure (Local Time)	9:38:00 AM	
Arrival (Local Time)	2:18:00 PM	

Line	Heading	Start Time (UTC)	Stop Time (UTC)	Speed (kt)	Notes
00532	NW	15:58:13	15:59:59	118.6	Laser stopped prematurely on line. Received an warning "Laser Safety monitor stopped Channel 1 and Channel 2: AGL altitude too old" ????
00532	NW	16:07:52	16:24:44	122.0	Reflight of first attempt of line 532.
00531	SE	16:28:52	16:37:29	128.1	REFLOWN USING REFLY PLAN, Light Haze/Smoke, 110 Deg Heading
00530	NW	16:45:58	16:47:48	124.9	REFLOWN USING REFLY PLAN, Light Haze/Smoke, 291 Heading
00533	SE	16:56:15	17:07:34	129.2	REFLOWN USING REFLY PLAN, Light Haze/Smoke, 110 Deg Heading
00534	NW	17:11:12	17:22:53	125.7	REFLOWN USING REFLY PLAN, Light Haze/Smoke, 291 Heading
00535	SE	17:26:22	17:37:31	131.8	REFLOWN USING REFLY PLAN, Light Haze/Smoke, 110 Deg Heading
00536	NW	17:40:09	17:50:54	124.5	REFLOWN USING REFLY PLAN, Light Haze/Smoke, 291 Heading
00537	SE	17:56:07	18:01:36	133.9	REFLOWN USING REFLY PLAN, XTIE @ 180538, 110 Deg Heading, Light Haze
Xtie	NE	18:05:38	18:10:52	133.8	CrossTie
00649	NE	18:50:04	18:59:51	128.7	Reflew western 20 nm, Moderate Haze, 44 Deg Heading
00357	SE	19:22:30	19:30:12	126.7	Attempted to fly Southern 20nm but laser stopped prematurely, Laser stopped prematurely on line. Received an warning "Laser Safety monitor stopped Channel 1 and Channel 2: AGL altitude too old" ???? Light Haze/Smoke, 134 Deg Heading
00358	NW	19:34:56	19:40:58	130.0	Reflew Southern 12 nm, Light Haze/ Smoke, 314 Deg Heading
00357	SE	19:47:15	19:50:16	130.0	Reflew southern tip of 357 as a precaution but manually intercepted so Mount did not uncage. 134 Deg Heading