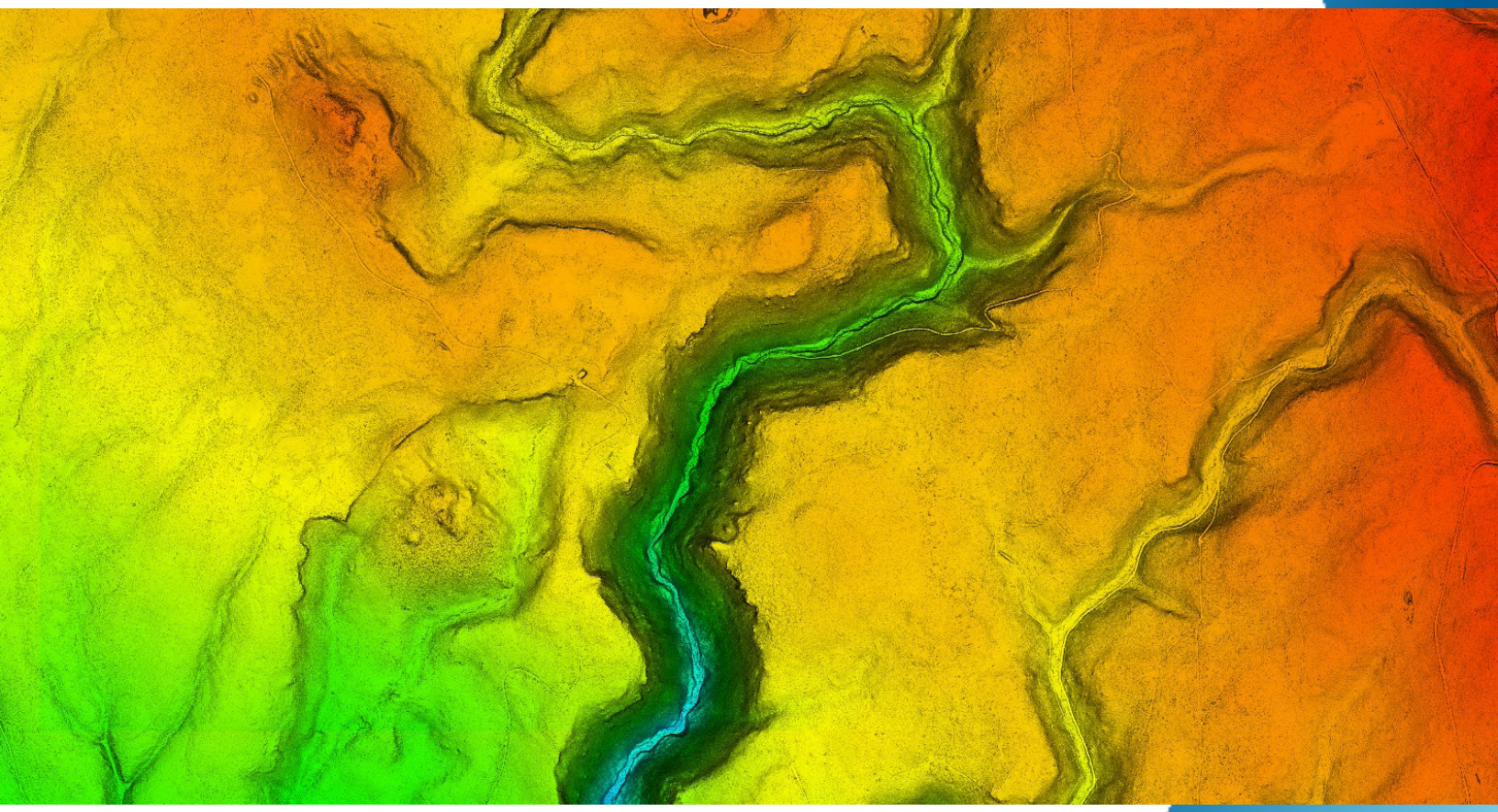
NV5 GEOSPATIAL



38184 Sycan LIDAR PROCESSING REPORT

2023

Submitted: March 15, 2023

Project ID: 221827
Work Unit: 221824

Prepared for:

USGS
science for a changing world

Prepared by:

NV5 GEOSPATIAL

Contents

List of Figures

List of Tables

List of Appendices

1. Summary / Scope

1.1. Summary

This report contains a summary of the 38184 Sycan, Work Unit 221824 lidar acquisition task order, issued by USGS under their Contract G16PC00016 on August 2, 2021. The task order yielded a work unit area covering 4,171 square miles over Oregon. This was collected 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
0.35 pts / m2	2,083 m	58.5°	20%	≤ 10 cm

1.3. Coverage

The Work Unit boundary covers 4,171 square miles over Oregon. Project extents are shown in Figure 1.

1.4. Duration

Lidar data was acquired from September 13, 2021 to July 21, 2022 in 22 total lifts. See “Section: 2.4. Time Period” for more details.

1.5. Issues

There were no issues to report.

38184 Sycan Work Unit 221824 Projected Coordinate System: UTM Zone 10N Horizontal Datum: NAD83 (2011) Vertical Datum: NAVD88 (GEOID 18) Units: Meters	
Lidar Point Cloud	Classified Point Cloud in .LAS 1.4 format
Rasters	• 0.5-meter Hydro-flattened Bare Earth Digital Elevation Model (DEM) in GeoTIFF format • 1-meter Intensity images in GeoTIFF format
Vectors	Shapefiles (*.shp) • Project Boundary • Lidar Tile Index • Calibration and QC Checkpoints (NVA/VVA) • Continuous Hydro-flattened Breaklines
Reports	Reports in PDF format • Focus on Delivery • Focus on Accuracy • Processing Report
Metadata	XML Files (*.xml) • Breaklines • Classified Point Cloud • DEM • DSM • Intensity Imagery

38184 Sycan
Work Unit 221824 Boundary

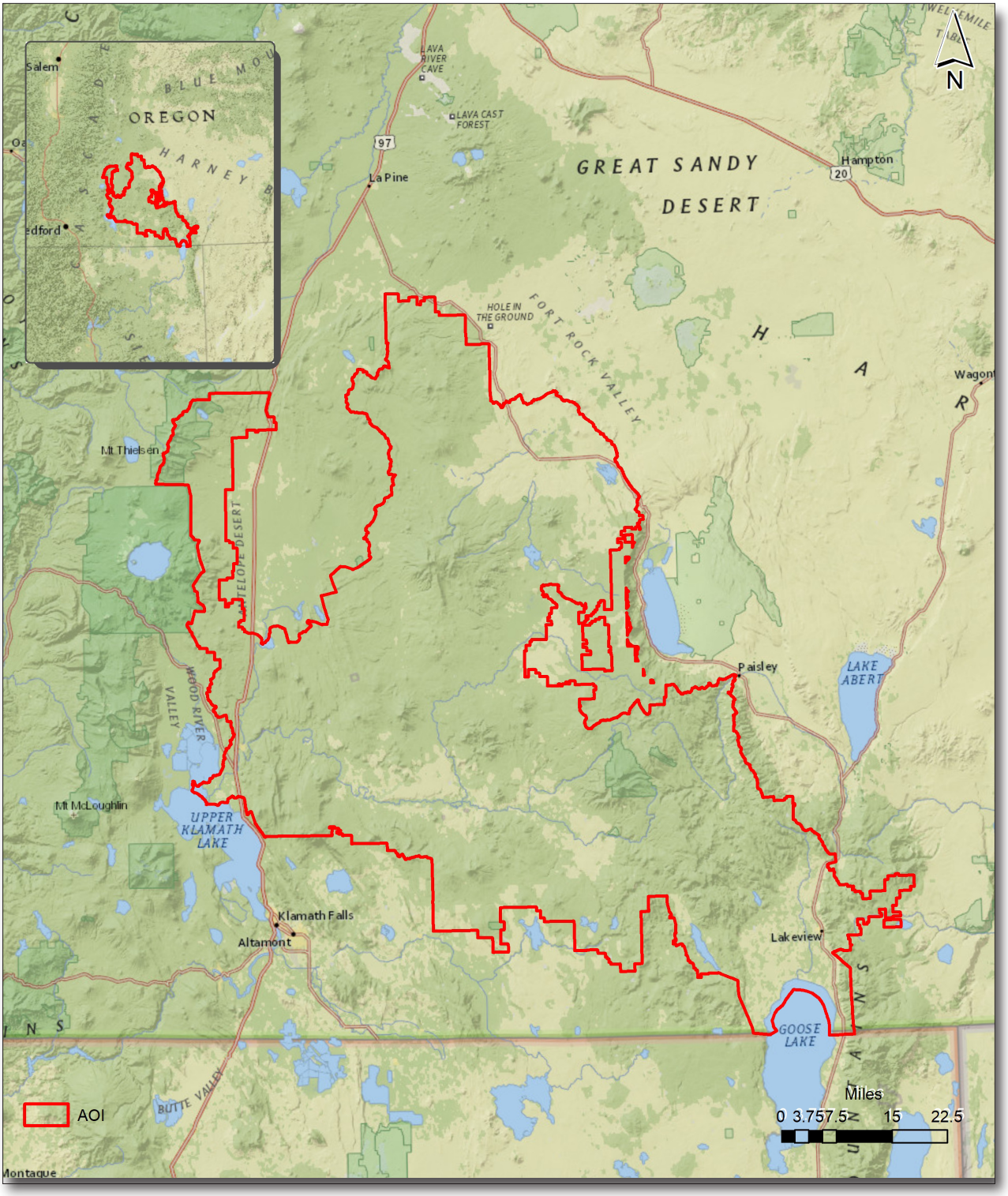


Figure 1. Work Unit Boundary

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) 3546 and 4045, 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 (SN3546)	Riegl VQ1560ii (SN4045)
Terrain and Aircraft Scanner	Flying Height	2500 m	2500 m
	Recommended Ground Speed	145 kts	145 kts
Scanner	Field of View	58.5°	58.5°
	Scan Rate Setting Used	102 x 2 Hz	102 x 2 Hz
Laser	Laser Pulse Rate Used	634 x 2 kHz	634 x 2 kHz
	Multi Pulse in Air Mode	yes	yes
Coverage	Full Swath Width	7385 m	7385 m
	Line Spacing	3323 m	3323 m
Point Spacing and Density	Average Point Spacing	0.35 m	0.35 m
	Average Point Density	8 pts / m^2	8 pts / m^2

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

- Piper Navajo (twin-piston), Tail Number(s): N350GB
- Cessna Caravan (single-turboprop), Tail Number(s): 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 Riegl VQ1560ii lidar system. Some of NV5 Geospatial's operating aircraft can be seen in Figure 3 below.

Figure 3. Some of NV5 Geospatial's Aircraft

2.4. Time Period

Project specific flights were conducted between September 13, 2021 to July 21, 2022. Twenty-two aircraft lifts were completed. Accomplished lifts are listed below.

Lift
20220720
20220721
20220722
20210913
20210916
20210917
20210923
20210925
20210927
20210928
20211004
20211005
20211006
20211006
20211007
20211008
20211011

2.4. Time Period

Project specific flights were conducted between September 13, 2021 to July 21, 2022. Twenty-two aircraft lifts were completed. Accomplished lifts are listed below.

Lift
20211011
20211013
20211019
20211020
20211021
20211023

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 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. The point cloud is imported into GeoCue distributive processing software. Imported data is tiled and then calibrated using TerraMatch and proprietary software. Using TerraScan, the vertical accuracy of the surveyed ground control is tested and any bias is removed from the data. TerraScan and TerraModeler software packages are then used for automated data classification and manual cleanup. The data are 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
GeoCue	2020.1.22.1
Global Mapper	19.1;20.1
TerraModeler	21.008
TerraScan	21.016
TerraMatch	21.007

3.3. LAS Classification Scheme

The classification classes are determined by Lidar Base Specifications 2020, Rev. 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 ground class, or any other project classification
2	Bare earth	Laser returns that are determined to be ground 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 ground 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 ground surface
20	Ignored Ground	Ground points that fall within the given threshold of a collected hydro feature.
21	Snow	Ground points that fall on snow, where identifiable
22	Temporal Exclusion	Points that are excluded due to differences in collection dates

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 completeness, 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

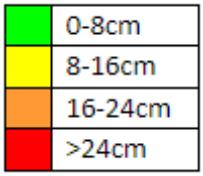
Intensity images represent reflectivity values collected by the lidar sensor during acquisition. Proprietary software generates intensity images using first returns and excluding those flagged with a withheld bit. Intensity images are linearly scaled to a value range specific to the project area to standardize 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.

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. Top of Canopy DSM Processing

First-return highest hit lidar points from the vegetation class were used to create a 0.5 meter raster DSM. Using automated scripting routines within proprietary software, TIF files were created for each tile. Each surface is reviewed using Global Mapper to check for any surface anomalies or incorrect elevations found within the surface.

3.11. Raster DSM Processing

A normalized digital surface model was created by removing the DEM surface from the DSM surface. This allows for the visualization of all features (cars, trees, buildings, etc.) that are above the ground level. Each surface is reviewed using Global Mapper to check for any surface anomalies or incorrect elevations found within the surface.

38184 Sycan
Work Unit 221824 Tile Layout

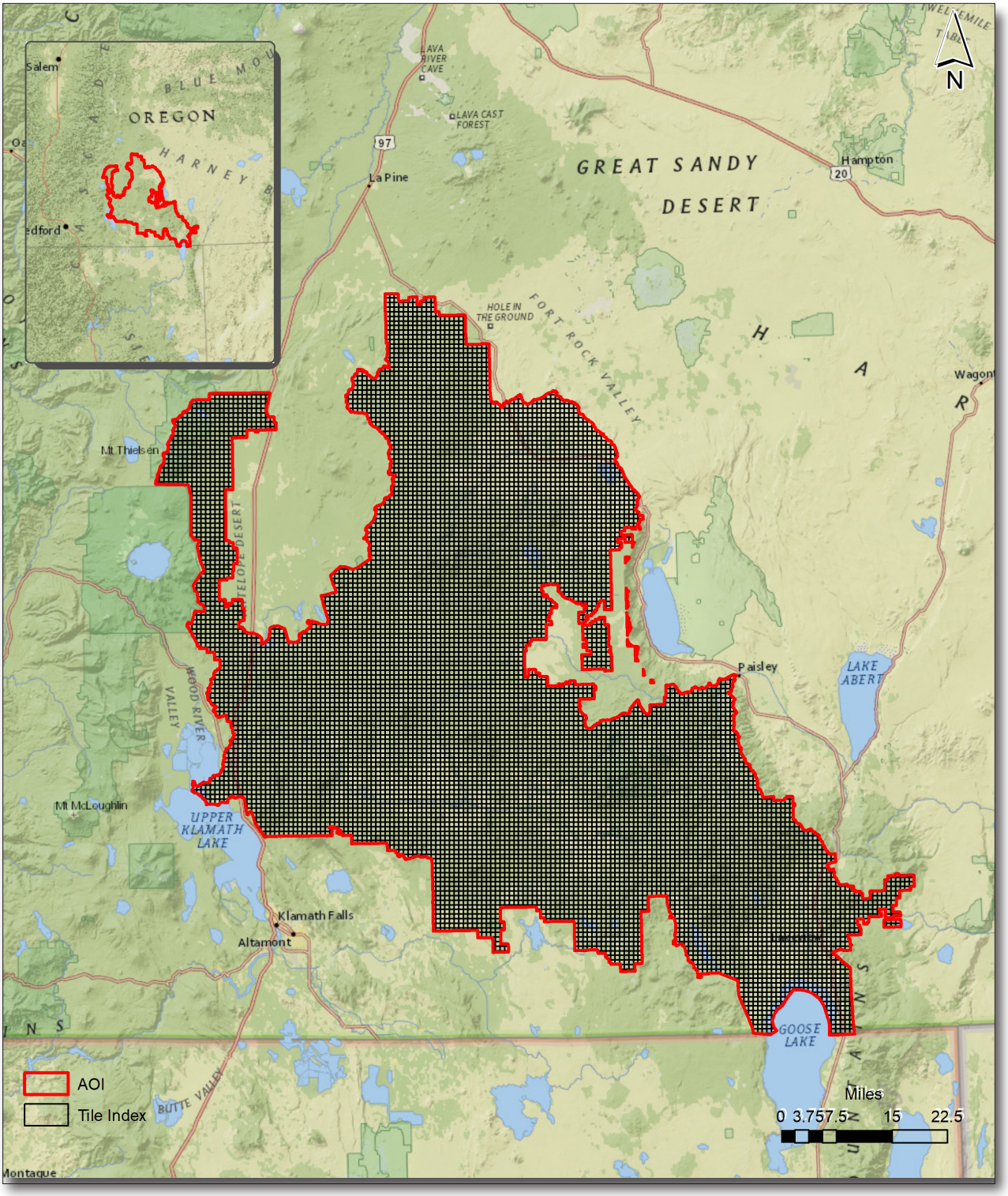


Figure 4. Lidar Tile Layout

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.

38184 Sycan
Work Unit 221824 Lidar Coverage

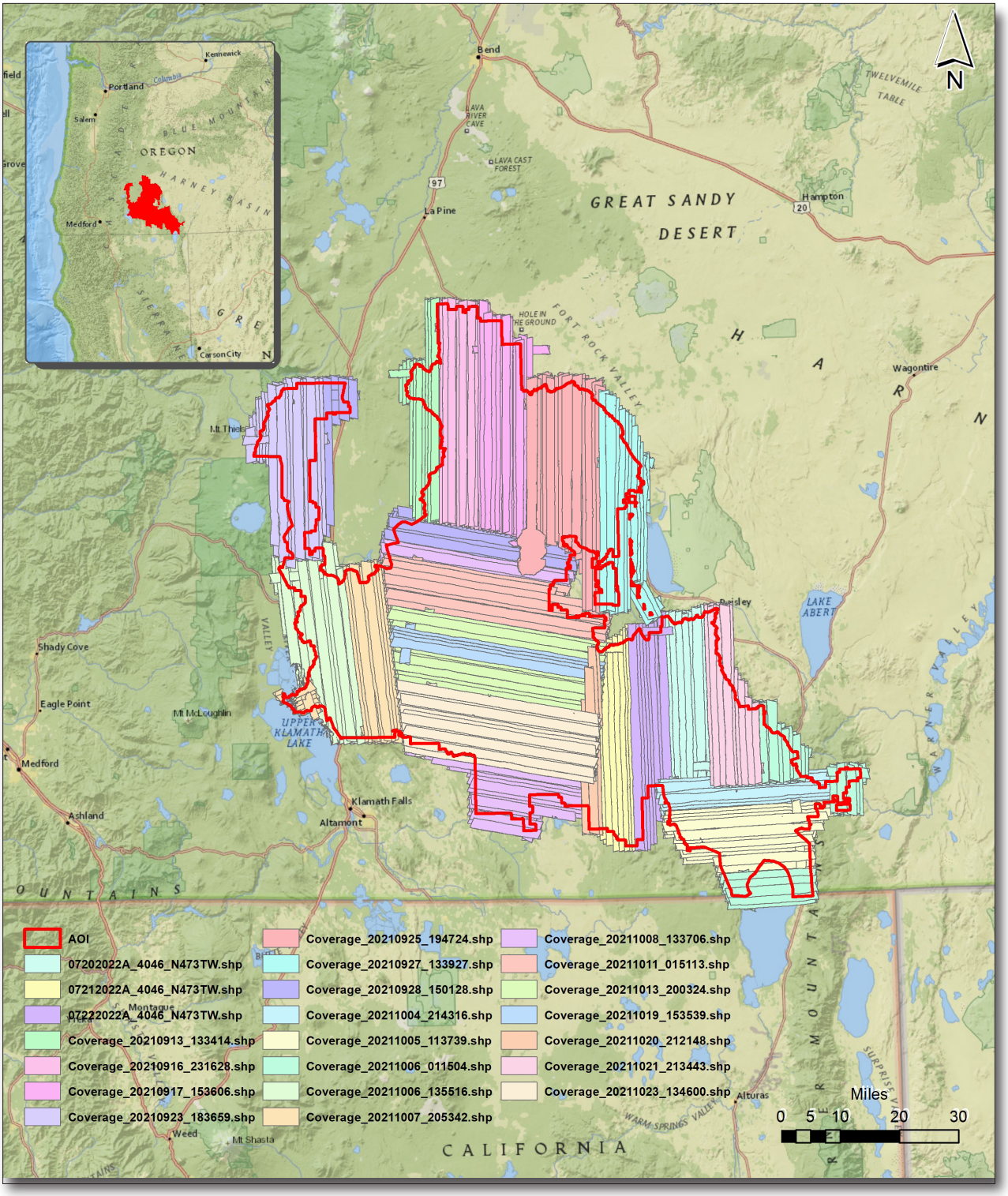


Figure 5. Lidar Coverage

5. Geometric Accuracy

5.1. Horizontal Accuracy

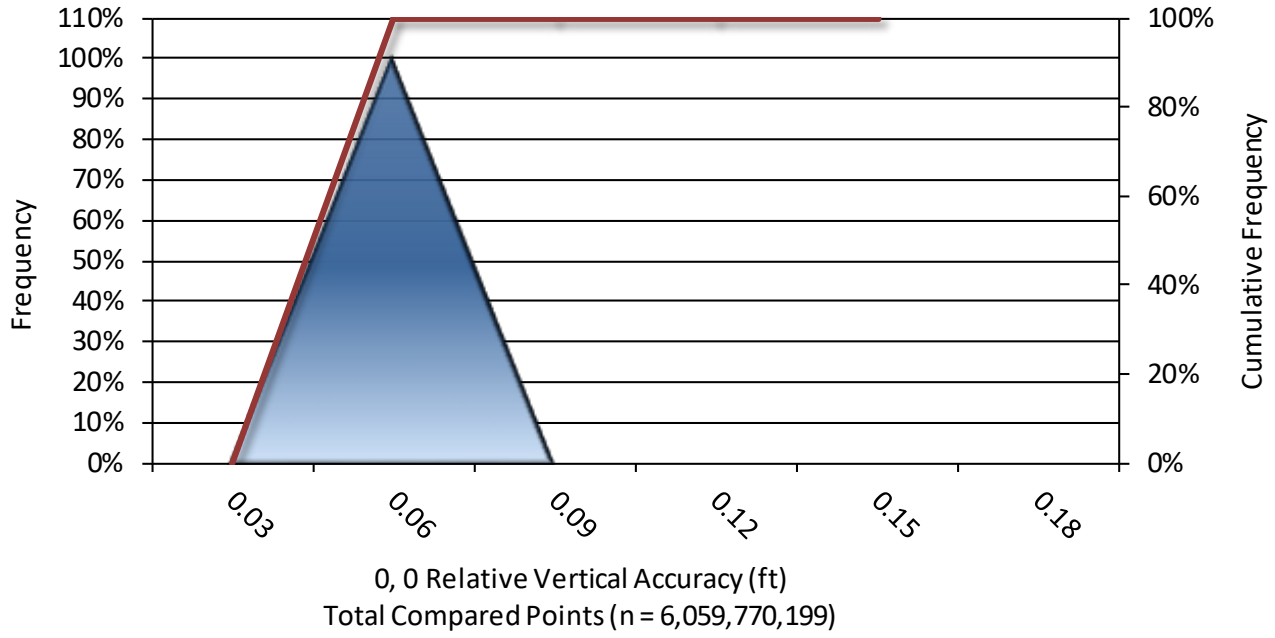
Lidar horizontal accuracy is a function of Global Navigation Satellite System (GNSS) derived positional error, flying altitude, and INS derived attitude error. The obtained $RMSE_r$ value is multiplied by a conversion factor of 1.7308 to yield the horizontal component of the National Standards for Spatial 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 2083 meters, an IMU error of 0.002 decimal degrees, and a GNSS positional error of 0.015 meters, this project was compiled to meet 0.23 meter horizontal accuracy at the 95% confidence level. A summary is shown below.

Horizontal Accuracy	
$RMSE_r$	0.43 ft
	0.13 m
ACC_r	0.75 ft
	0.23 m

5.2. 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 38184 Sycan project was 0.042 feet (0.013 meters). A summary is shown below.

Relative Vertical Accuracy	
Sample	60 flight line surfaces
Average	0.042 ft
	0.013 m
Median	0.042 ft
	0.013 m
RMSE	0.042 ft
	0.013 m
Standard Deviation (1σ)	0.003 ft
	0.001 m
1.96σ	0.006 ft
	0.002 m



Project Report Appendices

The following section contains the appendices as listed in the 38184 Sycan Lidar Project Report.

Appendix A

Flight Logs

Project	946621-R038184.00	USGS Sycan
Flightplan	USGS_WestCentSycan_1560ii_QL1	

Mission Name	S2224045_20210903_F1
Mission Date	9/3/2021
Aircraft	N840JA
Pilot	Chad Unangst
Co-Pilot	
Operator	Gary Tao
Co-Operator	
Vendor	NV5 Geospatial
Base Airport	KLMT
Departure (Local Time)	11:26:00 AM
Arrival (Local Time)	4:00:00 PM

Mission Notes

Crew of N840JA repositioned from CVO to LMT after the fuel flow gauge was repaired. Acquired 13 QL1 lines of R038184 USGS WestCentral Sycan AOI enroute utilizing Riegl VQ 1560ii/SN4045 on Friday, September 3. Will be doublecrewing project beginning September 4.

Line	Heading	Start Time (UTC)	Stop Time (UTC)	Speed (kt)	Notes
00005	N	19:22:00	19:24:16	144.8	Light Smoke/Haze
00006	S	19:27:04	19:29:47	141.6	Light Smoke/Haze
00007	N	19:32:13	19:34:56	142.8	Light Smoke/Haze
00008	S	19:37:56	19:47:03	140.4	Light Smoke/Haze
00009	N	19:50:28	20:00:05	145.5	Light Smoke/Haze
00010	S	20:02:38	20:12:40	140.1	PCS disconnect at end of line.
00011	N	20:19:58	20:29:53	143.0	Light Smoke/Haze
00012	S	20:32:31	20:42:48	138.0	Light Smoke/Haze
00013	N	20:45:09	20:58:43	143.6	Light Smoke/Haze
00014	S	21:01:22	21:15:42	136.3	Light Smoke/Haze
00015	N	21:18:15	21:32:13	140.3	Light Smoke/Haze
00016	S	21:34:37	21:49:02	135.1	PD PCS error encountered at ~4NM from southern end.
00016	N	21:54:03	21:56:54	140.1	Reflight of southern 6nm
00017	N	22:03:51	22:17:50	142.0	Light Smoke/Haze
CrossTie	SW	22:23:59	22:28:55	138.5	Light Smoke/Haze

Project	946621-R038184.00	USGS Sycan
Flightplan	USGS_WestCentSycan_1560ii_QL1	

Mission Name	S2224045_20210913_F1	**Mission Notes**
Mission Date	9/13/2021	
Aircraft	N840JA	
Pilot	Christopher Griffin	
Co-Pilot		
Operator	Jonathan Swan	
Co-Operator		
Vendor	NV5 Geospatial	
Base Airport	KBDN	
Departure (Local Time)	11:14:00 AM	
Arrival (Local Time)	5:06:00 PM	

Line	Heading	Start Time (UTC)	Stop Time (UTC)	Speed (kt)	Notes
00018	S	18:59:15	19:13:06	142.3	
00019	N	19:15:54	19:29:49	142.0	
00020	S	19:32:30	19:46:19	143.4	
00021	N	19:49:18	20:03:05	144.0	
00022	S	20:05:42	20:19:41	142.3	
00023	N	20:22:15	20:35:57	144.1	
00024	S	20:38:18	20:52:12	142.1	
00025	N	20:55:09	21:09:12	141.1	
00026	S	21:12:12	21:26:05	142.8	
00027	N	21:28:41	21:42:41	141.8	
00028	S	21:45:10	21:59:09	142.3	
00029	N	22:01:43	22:16:06	138.6	
00030	S	22:18:47	22:32:47	142.4	
00031	N	22:34:45	22:39:31	142.2	
00031	N	22:50:11	23:04:28	139.0	
00032	S	23:06:48	23:20:53	141.8	
00033	N	23:23:13	23:37:37	139.1	

Project	946621-R038184.00	USGS Sycan
Flightplan	USGS_WestCentSycan_1560ii_QL1	

Mission Name	S2224045_20210914_F1	**Mission Notes**
Mission Date	9/14/2021	
Aircraft	N840JA	
Pilot	Christopher Griffin	
Co-Pilot		
Operator	Jonathan Swan	
Co-Operator		
Vendor	NV5 Geospatial	
Base Airport	KBDN	
Departure (Local Time)	9:04:00 AM	
Arrival (Local Time)	3:30:00 PM	

Line	Heading	Start Time (UTC)	Stop Time (UTC)	Speed (kt)	Notes
00034	S	16:26:23	16:40:20	143.8	
00035	N	16:43:11	16:57:19	142.2	
00036	S	16:59:58	17:13:57	143.8	
00037	N	17:16:11	17:29:40	142.0	
00038	S	17:31:52	17:44:59	144.1	
00039	N	17:47:24	18:00:37	143.4	
00040	S	18:02:43	18:15:54	144.0	
00041	N	18:18:05	18:31:37	140.5	
00042	S	18:41:19	18:54:46	142.0	
00043	N	18:57:16	19:10:40	142.3	
00044	S	19:12:54	19:13:38	144.3	
00044	S	19:22:57	19:36:31	141.0	
00045	N	19:38:54	19:52:28	141.3	
00046	S	19:55:04	20:08:31	143.0	
00047	N	20:10:41	20:22:58	140.3	
00048	S	20:25:20	20:37:36	141.1	
00049	N	20:43:41	20:56:02	140.0	
00050	S	20:58:21	21:11:12	143.4	
00051	N	21:13:32	21:26:04	140.9	
00052	S	21:29:44	21:42:05	140.8	
00052	N	21:46:04	21:58:51	138.1	

Project	946621-R038184.00	USGS Sycan
Flightplan	USGS_Sycan_QL1_1560iiS_v2	

Mission Name	S2223061_20211015_F1	**Mission Notes**
Mission Date	10/15/2021	
Aircraft	N208JA	
Pilot	Mike Schrum	
Co-Pilot		
Operator	Mark Smith	
Co-Operator		
Vendor	NV5 Geospatial	
Base Airport	KBOI	
Departure (Local Time)	9:20:00 AM	
Arrival (Local Time)	3:16:00 PM	

Line	Heading	Start Time (UTC)	Stop Time (UTC)	Speed (kt)	Notes
02202	S	16:53:57	17:00:11	143.3	
02201	N	17:02:18	17:08:29	144.1	
02200	S	17:10:09	17:16:16	145.6	
02199	N	17:18:22	17:24:33	144.1	
02198	S	17:26:43	17:32:52	144.9	
02197	N	17:34:57	17:41:03	143.8	
02196	S	17:43:28	17:48:55	145.0	
02195	N	17:50:52	17:55:56	144.4	
02194	N	17:56:31	17:56:35	148.7	
02194	S	17:58:12	18:03:45	145.1	
02193	N	18:05:58	18:12:24	142.8	
02192	S	18:14:18	18:20:15	143.5	
02191	N	18:22:23	18:28:01	144.0	
02190	S	18:29:56	18:35:11	144.2	
02188	N	18:37:53	18:43:05	140.5	
02189	S	18:45:36	18:50:50	142.8	
02187	N	18:52:49	18:57:58	137.1	
02186	S	19:00:07	19:04:50	144.6	
02185	N	19:06:54	19:10:23	144.4	
02186	E	19:13:03	19:17:37	148.5	

Project	946621-R038184.00	USGS Sycan
Flightplan	USGS_Sycan_QL1_1560iiS_v2	

Mission Name	S2223546_20210917_F1	**Mission Notes**
Mission Date	9/17/2021	Took off after Dan installed the license on the Laptop.
Aircraft	N840JA	Flew One full Fuel load to finish both PGE Rework and then onto acquire on USGS West Sycan.
Pilot	Daniel Luckett	It was very smoky on the West Sycan project
Co-Pilot		
Operator	Jonathan Swan	
Co-Operator		
Vendor	NV5 Geospatial	
Base Airport	KBDN	
Departure (Local Time)	10:00:00 AM	
Arrival (Local Time)	4:50:00 PM	

Line	Heading	Start Time (UTC)	Stop Time (UTC)	Speed (kt)	Notes
test	S	18:52:38	18:53:01	150.8	
test	S	19:04:01	19:04:10	147.2	
02219	S	19:08:26	19:10:39	140.8	
02220	N	19:12:47	19:15:35	139.2	
02221	S	19:17:41	19:20:51	138.8	
02222	N	19:22:32	19:26:23	143.7	
02223	S	19:28:08	19:32:15	139.0	
02224	N	19:34:02	19:38:20	140.7	
02225	S	19:39:55	19:44:23	144.5	
02226	S	19:49:24	19:49:49	146.1	false trigger
02226	N	19:51:16	20:01:03	145.3	
02227	S	20:02:52	20:13:24	144.0	
02228	N	20:14:49	20:25:18	146.4	
02229	S	20:27:20	20:38:10	143.8	
02230	N	20:43:07	20:53:47	145.8	
02231	S	20:55:15	21:07:03	140.6	
02232	N	21:18:00	21:29:00	145.0	
02233	S	21:30:51	21:42:25	138.1	
02234	N	21:43:44	21:54:45	145.0	
02235	S	21:56:19	22:07:41	140.5	
02236	N	22:09:19	22:20:35	141.6	
02237	S	22:22:12	22:34:09	133.3	
02238	N	22:35:26	22:46:33	143.4	
02239	S	22:48:06	22:59:55	135.1	
02240	N	23:02:26	23:12:05	144.0	
xtie	SW	23:17:27	23:22:52	136.9	

Project	946621-R038184.00	USGS Sycan
Flightplan	USGS_Sycan_QL1_1560iiS_v2	

Mission Name	S2223546_20210920_F1	**Mission Notes**
Mission Date	9/20/2021	
Aircraft	N840JA	
Pilot	Daniel Luckett	
Co-Pilot		
Operator	Matthew Moudy	
Co-Operator		
Vendor	NV5 Geospatial	
Base Airport	KBDN	
Departure (Local Time)	10:56:00 AM	
Arrival (Local Time)	4:34:00 PM	

Line	Heading	Start Time (UTC)	Stop Time (UTC)	Speed (kt)	Notes
02041	S	18:18:20	18:34:02	139.7	SKC
02041	N	18:34:05	18:34:19	142.8	aborted line
02042	N	18:36:48	18:47:56	132.2	SKC
02043	S	18:49:27	18:59:21	146.2	SKC
02044	N	19:00:34	19:11:43	133.7	SKC
02045	S	19:12:58	19:22:54	147.9	line 2045, SKC
02046	N	19:24:08	19:35:29	129.2	SKC
02047	S	19:36:40	19:46:42	145.6	SKC
02048	N	19:48:06	19:58:58	134.3	line 2048, SKC
02049	S	19:59:56	20:10:28	145.0	SKC
02050	N	20:18:53	20:30:19	133.3	SKC
02051	S	20:31:37	20:42:15	146.6	SKC
02052	N	20:44:45	20:56:40	130.2	SKC
02053	S	20:57:54	21:08:38	146.6	SKC
02053	N	21:10:00	21:10:19	82.5	aborted line
02054	N	21:12:58	21:25:14	132.3	line 2054, SKC
02055	S	21:26:30	21:38:25	145.5	SKC
02056	N	21:42:23	21:57:34	134.1	SKC
02057	S	21:58:52	22:12:29	149.1	SKC
02058	N	22:13:41	22:29:05	133.1	SKC
02059	S	22:30:09	22:44:03	145.5	line 2059, SKC
02060	N	22:45:12	23:00:05	134.9	SKC
x-line	SW	23:02:08	23:07:14	145.9	x-line, SKC

Project	946621-R038184.00	USGS Sycan
Flightplan	USGS_Sycan_QL1_1560iiS_v2	

Mission Name	S2223546_20210921_F1	**Mission Notes**
Mission Date	9/21/2021	
Aircraft	N840JA	
Pilot	Daniel Luckett	
Co-Pilot		
Operator	Matthew Moudy	
Co-Operator		
Vendor	NV5 Geospatial	
Base Airport	KBDN	
Departure (Local Time)	10:11:00 AM	
Arrival (Local Time)	2:44:00 PM	

Line	Heading	Start Time (UTC)	Stop Time (UTC)	Speed (kt)	Notes
02061	S	17:39:53	17:53:51	139.2	Dir 167, SKC
02062	N	17:55:26	18:08:43	146.2	Dir 347, SKC
02063	S	18:11:48	18:25:21	141.0	Dir 167, SKC
02064	N	18:27:26	18:40:28	145.4	Dir 347, SKC
02065	S	18:42:08	18:54:46	142.7	Dir 167, SKC
02066	N	18:56:36	19:09:01	144.4	Dir 347, SKC
02067	S	19:10:18	19:22:46	142.6	Dir 167, SKC
02068	N	19:24:42	19:36:31	146.0	Dir 347, SKC
02069	S	19:37:59	19:48:10	143.9	Dir 167, SKC
02070	N	19:49:44	19:59:15	143.9	Dir 347, SKC
02071	S	20:02:34	20:11:27	143.0	Dir 167, SKC
02072	N	20:15:33	20:24:26	140.5	Dir 347, SKC
02073	S	20:26:21	20:34:10	141.5	Dir 167, SKC
02000	SE	20:38:08	20:41:14	146.5	Dir 139, SKC
02001	NW	20:42:48	20:45:52	143.8	Dir 319, SKC
02002	SE	20:47:38	20:50:55	141.6	Dir 139, SKC
x-line	SW	20:53:32	20:55:07	137.0	x-line
02074	N	21:01:31	21:05:06	146.2	Dir 347, SKC
x-line	SW	21:07:16	21:10:46	139.5	x-line

Project	946621-R038184.00	USGS Sycan
Flightplan	USGS_Sycan_QL1_1560iiS_v2	

Mission Name	S2223546_20210922_F1	**Mission Notes**
Mission Date	9/22/2021	
Aircraft	N840JA	
Pilot	Daniel Luckett	
Co-Pilot		
Operator	Matthew Moudy	
Co-Operator		
Vendor	NV5 Geospatial	
Base Airport	KBDN	
Departure (Local Time)	8:57:00 AM	
Arrival (Local Time)	2:01:00 PM	

Line	Heading	Start Time (UTC)	Stop Time (UTC)	Speed (kt)	Notes
02248	S	16:30:08	16:32:45	133.6	
02247	N	16:34:34	16:37:05	144.5	
02246	S	16:38:47	16:41:34	133.6	
02245	N	16:44:24	16:47:02	141.8	
02244	S	16:49:00	16:52:03	140.7	
02243	N	16:53:30	16:56:22	149.4	
02242	S	16:57:55	17:07:34	134.5	
02241	N	17:10:02	17:19:46	144.0	
x-line	E	17:23:05	17:25:48	145.1	
02075	E	17:34:37	17:44:31	146.5	
02076	SW	17:47:03	17:59:44	129.1	
02077	E	18:01:26	18:13:18	141.6	
02078	SW	18:15:14	18:28:13	130.1	
02079	E	18:29:36	18:41:41	142.6	
02080	SW	18:43:13	18:56:10	132.6	
02081	E	18:57:10	19:09:11	142.8	
02082	SW	19:10:30	19:23:52	128.3	
02083	E	19:25:04	19:37:02	143.9	
02084	SW	19:38:29	19:51:44	129.5	
02085	E	19:53:30	20:05:58	139.2	
02086	SW	20:07:11	20:20:52	126.5	
x-line	N	20:24:38	20:28:04	148.0	

Project	946621-R038184.00	USGS Sycan
Flightplan	USGS_Sycan_QL1_1560iiS_v2	

Mission Name	S2223546_20210929_F1	**Mission Notes**
Mission Date	9/29/2021	
Aircraft	N840JA	
Pilot	Jamon Neilson	
Co-Pilot		
Operator	Jonathan Frech	
Co-Operator		
Vendor	NV5 Geospatial	
Base Airport	KBDN	
Departure (Local Time)	8:50:00 AM	
Arrival (Local Time)	4:40:00 PM	

Line	Heading	Start Time (UTC)	Stop Time (UTC)	Speed (kt)	Notes
02360	E	20:19:53	20:30:58	145.6	
02361	SW	20:34:05	20:45:35	140.3	
02362	E	20:48:50	20:59:51	146.2	
02363	SW	21:03:11	21:14:23	144.2	
02364	E	21:17:38	21:28:54	141.7	
02365	SW	21:32:18	21:43:40	140.5	
02366	E	21:47:06	21:58:19	142.2	
02367	SW	22:02:06	22:13:31	138.9	
02368	E	22:16:42	22:27:33	145.8	
02369	SW	22:31:28	22:43:11	135.2	

Project	946621-R038184.00	USGS Sycan
Flightplan	USGS_Sycan_QL1_1560iiS_v2	

Mission Name	S2223546_20210930_F1	**Mission Notes**
Mission Date	9/30/2021	Good flight no issues
Aircraft	N840JA	
Pilot	Jamon Neilson	
Co-Pilot		
Operator	Justen Maxey	
Co-Operator		
Vendor	NV5 Geospatial	
Base Airport	KBDN	
Departure (Local Time)	9:22:00 AM	
Arrival (Local Time)	3:11:00 PM	

Line	Heading	Start Time (UTC)	Stop Time (UTC)	Speed (kt)	Notes
02370	E	17:20:41	17:31:12	149.0	
02371	SW	17:34:52	17:45:35	144.1	
02372	E	18:02:07	18:13:03	141.2	
02373	SW	18:16:44	18:26:51	143.4	
02374	E	18:30:45	18:40:32	142.2	
02375	SW	18:43:48	18:53:33	142.7	
02376	E	18:57:34	19:06:45	143.0	
02377	SW	19:10:26	19:19:07	142.6	
02378	E	19:22:38	19:31:17	143.0	
02379	SW	19:34:29	19:42:57	143.0	
02380	E	19:46:16	19:54:24	143.8	
02381	SW	19:58:09	20:06:18	143.1	
02382	E	20:09:32	20:17:28	144.3	
02383	SW	20:20:53	20:28:54	142.7	
02384	E	20:33:32	20:39:42	145.9	
02385	SW	20:43:29	20:49:33	141.6	
02386	E	20:52:56	20:58:48	147.0	
02387	SW	21:02:15	21:08:20	141.3	
02388	E	21:11:40	21:17:27	147.5	
xline	N	21:19:46	21:24:29	145.1	

Project	946621-R038184.00	USGS Sycan
Flightplan	USGS_Sycan_QL1_1560iiS_v2	

Mission Name	S2223546_20211001_F1	**Mission Notes**
Mission Date	10/1/2021	Good flight no issues.
Aircraft	N840JA	
Pilot	Jamon Neilson	
Co-Pilot		
Operator	Justen Maxey	
Co-Operator		
Vendor	NV5 Geospatial	
Base Airport	KBDN	
Departure (Local Time)	9:00:00 AM	
Arrival (Local Time)	2:50:00 PM	

Line	Heading	Start Time (UTC)	Stop Time (UTC)	Speed (kt)	Notes
02389	E	17:06:19	17:12:06	146.0	
02390	SW	17:15:15	17:21:51	126.8	
02391	E	17:25:09	17:30:53	144.3	
02392	SW	17:34:24	17:40:22	136.4	
02393	E	17:43:34	17:48:55	149.9	
02394	SW	17:52:03	17:58:06	131.1	
02395	E	18:00:56	18:06:11	148.5	
02396	SW	18:09:31	18:15:01	141.5	
xline	N	18:17:58	18:20:08	159.2	
02397	N	18:27:14	18:30:03	151.8	
02398	S	18:33:13	18:36:23	140.2	
02399	N	18:39:40	18:42:37	150.5	
02400	S	18:46:27	18:49:40	137.0	
02401	N	18:52:56	18:55:52	151.3	
02402	S	18:59:43	19:02:54	139.1	
02403	N	19:05:55	19:08:57	145.9	
02404	S	19:12:21	19:15:43	131.4	
02405	N	19:19:06	19:20:14	154.6	
xline	SW	19:22:33	19:25:12	137.6	
02318	N	19:28:54	19:30:45	151.0	
02317	S	19:33:55	19:36:15	136.6	
02316	N	19:39:26	19:42:07	145.7	
02315	S	19:46:26	19:49:37	136.4	
02314	N	19:53:15	19:56:27	145.8	
02313	S	19:59:40	20:03:10	133.7	
02312	N	20:07:24	20:10:48	146.9	
02311	S	20:14:14	20:18:06	135.8	
02310	N	20:21:59	20:26:57	142.1	
02309	S	20:30:08	20:35:17	137.1	
02308	N	20:38:18	20:43:08	146.2	
02307	S	20:46:06	20:51:12	139.2	
02306	N	20:54:49	20:59:40	147.2	
xline	E	21:05:36	21:08:46	159.4	

Project	946621-R038184.00	USGS Sycan
Flightplan	USGS_Sycan_QL1_1560iiS_v2	

Mission Name	S2223546_20211002_F1	**Mission Notes**
Mission Date	10/2/2021	Good flight no issues.
Aircraft	N840JA	
Pilot	Jamon Neilson	
Co-Pilot		
Operator	Justen Maxey	
Co-Operator		
Vendor	NV5 Geospatial	
Base Airport	KBDN	
Departure (Local Time)	9:15:00 AM	
Arrival (Local Time)	3:12:00 PM	

Line	Heading	Start Time (UTC)	Stop Time (UTC)	Speed (kt)	Notes
02326	S	16:58:17	17:00:43	136.1	
02327	N	17:06:32	17:12:01	132.2	
02328	S	17:15:00	17:23:14	143.6	
02329	N	17:27:10	17:37:04	134.7	
02330	S	17:39:57	17:49:48	144.3	
02331	N	17:52:57	18:03:33	134.1	
02332	S	18:06:25	18:16:59	146.2	
02333	N	18:20:24	18:31:33	140.6	
02334	S	18:34:34	18:46:12	143.7	
02335	N	18:49:23	19:01:56	139.8	
02336	S	19:04:54	19:16:42	149.2	
02337	N	19:19:50	19:32:09	143.0	
02338	S	19:35:22	19:47:34	144.6	
02339	N	19:50:44	20:02:49	146.1	
02340	S	20:05:59	20:18:21	143.2	
02341	N	20:21:15	20:33:40	142.3	
02342	S	20:37:04	20:49:29	142.5	
02343	N	20:52:15	21:03:05	143.8	
02344	S	21:06:24	21:17:23	142.0	
02345	N	21:20:09	21:31:00	144.1	
xline	SW	21:32:56	21:38:03	141.3	

Project	946621-R038184.00	USGS Sycan
Flightplan	USGS_Sycan_QL1_1560iiS_v2	

Mission Name	S2223546_20211003_F1	**Mission Notes**
Mission Date	10/3/2021	Good flight no issues
Aircraft	N840JA	
Pilot	Jamon Neilson	
Co-Pilot		
Operator	Justen Maxey	
Co-Operator		
Vendor	NV5 Geospatial	
Base Airport	KBDN	
Departure (Local Time)	9:15:00 AM	
Arrival (Local Time)	2:47:00 PM	

Line	Heading	Start Time (UTC)	Stop Time (UTC)	Speed (kt)	Notes
02319	SW	16:57:27	16:59:37	153.0	
02320	NE	17:02:28	17:04:44	145.2	
02321	SW	17:07:42	17:10:07	136.2	
02322	NE	17:13:02	17:15:14	149.0	
02323	SW	17:18:39	17:20:56	139.8	
02324	NE	17:23:50	17:25:42	151.3	
02325	SW	17:28:37	17:30:31	140.7	
xline	N	17:33:26	17:36:12	145.2	
02346	N	17:46:05	17:56:46	146.6	
02347	S	18:00:08	18:11:18	140.8	
02348	N	18:14:28	18:25:26	143.6	
02349	S	18:28:36	18:39:50	140.5	
02350	N	18:42:56	18:53:55	143.9	
02351	S	18:56:59	19:08:06	141.2	
02352	N	19:11:34	19:22:31	145.7	
02353	S	19:25:35	19:36:57	140.2	
02354	N	19:39:51	19:50:57	144.2	
02355	S	19:54:04	20:05:22	141.9	
02356	N	20:08:10	20:19:20	143.9	
02357	S	20:22:19	20:33:35	142.7	
02358	N	20:36:20	20:47:25	144.1	
02359	S	20:50:28	21:01:40	141.7	
xline	SW	21:04:18	21:08:18	139.4	

Project	946621-R038184.00	USGS Sycan
Flightplan	USGS_Sycan_QL1_1560iiS_v2	

Mission Name	S2223546_20211004_F1	**Mission Notes**
Mission Date	10/4/2021	We started in the north but hit rain. We jumped down south for the remainder of the day.
Aircraft	N840JA	
Pilot	Jamon Neilson	
Co-Pilot		
Operator	Justen Maxey	
Co-Operator		
Vendor	NV5 Geospatial	
Base Airport	KBDN	
Departure (Local Time)	9:15:00 AM	
Arrival (Local Time)	3:00:00 PM	

Line	Heading	Start Time (UTC)	Stop Time (UTC)	Speed (kt)	Notes
02087	E	16:57:30	17:09:12	145.5	
02088	SW	17:12:14	17:23:48	145.4	
02089	E	17:26:51	17:38:22	145.9	
02090	SW	17:41:32	17:52:58	147.1	
02158	E	18:11:47	18:16:02	143.7	
02157	SW	18:19:17	18:24:13	125.3	
02156	E	18:27:29	18:31:45	146.7	
02155	SW	18:34:56	18:39:34	136.5	
02154	E	18:42:37	18:46:58	145.7	
02153	SW	18:50:24	18:54:55	140.3	
02152	E	18:58:20	19:04:46	145.3	
02151	SW	19:08:48	19:16:43	135.4	
02150	E	19:19:43	19:27:09	145.2	
02149	SW	19:30:26	19:38:27	135.4	
02148	E	19:41:40	19:49:06	147.0	
02147	SW	19:52:19	20:00:36	132.5	
02146	E	20:03:57	20:11:24	148.0	
02145	SW	20:14:58	20:22:55	139.5	
02144	E	20:27:48	20:36:41	146.9	
02143	SW	20:40:41	20:51:25	133.6	
02142	E	20:56:54	21:08:28	146.0	
xline	S	21:14:10	21:19:15	139.3	

Project	946621-R038184.00	USGS Sycan
Flightplan	USGS_Sycan_QL1_1560iiS_v2	

Mission Name	S2223546_20211005_F1	**Mission Notes**
Mission Date	10/5/2021	Very windy all flight. Otherwise decent day.
Aircraft	N840JA	
Pilot	Jamon Neilson	
Co-Pilot		
Operator	Justen Maxey	
Co-Operator		
Vendor	NV5 Geospatial	
Base Airport	KBDN	
Departure (Local Time)	9:05:00 AM	
Arrival (Local Time)	2:50:00 PM	

Line	Heading	Start Time (UTC)	Stop Time (UTC)	Speed (kt)	Notes
02091	E	16:54:12	16:54:25	163.9	
02091	E	17:20:07	17:31:38	144.4	
02092	SW	17:35:48	17:47:41	130.4	
02093	E	17:51:03	18:02:13	143.0	
02094	SW	18:08:21	18:22:51	139.3	
02095	E	18:26:40	18:40:41	143.5	
02096	SW	18:44:05	18:59:08	133.6	
02097	E	19:02:19	19:16:18	142.8	
02098	SW	19:19:44	19:33:36	143.6	
02099	E	19:37:19	19:50:55	145.6	
02100	SW	19:54:47	20:08:55	139.6	
02101	E	20:12:48	20:26:20	145.1	
02102	SW	20:29:59	20:43:57	139.9	
02103	E	20:47:10	21:00:09	147.5	
02104	SW	21:03:49	21:17:25	141.9	
xline	N	21:19:33	21:22:43	167.4	

Project	946621-R038184.00	USGS Sycan
Flightplan	USGS_Sycan_QL1_1560iiS_v2	

Mission Name	S2223546_20211009_F1	**Mission Notes**
Mission Date	10/9/2021	Good flight today. We had to move once due to clouds.
Aircraft	N840JA	
Pilot	Jamon Neilson	
Co-Pilot		
Operator	Justen Maxey	
Co-Operator		
Vendor	NV5 Geospatial	
Base Airport	KBDN	
Departure (Local Time)	9:05:00 AM	
Arrival (Local Time)	2:45:00 PM	

Line	Heading	Start Time (UTC)	Stop Time (UTC)	Speed (kt)	Notes
02105	E	16:48:29	17:01:55	143.2	
02106	SW	17:05:35	17:18:51	144.8	
02107	E	17:23:17	17:36:41	142.9	
02108	SW	17:39:55	17:52:58	146.4	
02109	E	17:56:17	18:09:30	144.0	
02110	SW	18:12:45	18:25:44	146.2	
02115	E	18:28:08	18:41:40	137.8	
02116	SW	18:45:25	18:58:51	138.5	
02117	E	19:01:53	19:15:09	139.8	
02118	SW	19:18:34	19:31:59	137.5	
02119	E	19:35:05	19:47:17	150.7	
02120	SW	19:50:14	20:02:59	143.8	
02121	E	20:06:15	20:18:59	143.4	
02122	SW	20:22:05	20:34:36	145.1	
02123	E	20:38:02	20:50:44	142.8	
02124	SW	20:53:52	21:06:12	146.3	
xline	N	21:08:53	21:14:02	147.0	

Project	946621-R038184.00	USGS Sycan
Flightplan	USGS_Sycan_QL1_1560iiS_v2	

Mission Name	S2223546_20211012_F1	**Mission Notes**
Mission Date	10/12/2021	We started on Sycan, got 4 lines done. It cleared up over Creswell so we mob'd over and took care of that project.
Aircraft	N840JA	
Pilot	Jamon Neilson	
Co-Pilot		
Operator	Justen Maxey	
Co-Operator		
Vendor	NV5 Geospatial	
Base Airport	KBDN	
Departure (Local Time)	9:50:00 AM	
Arrival (Local Time)	2:15:00 PM	

Line	Heading	Start Time (UTC)	Stop Time (UTC)	Speed (kt)	Notes
02111	E	17:33:27	17:46:33	144.5	
02112	SW	17:51:11	18:04:21	143.3	
02113	E	18:08:29	18:21:51	140.7	
02114	SW	18:25:02	18:38:22	140.5	
xline	N	18:43:59	18:46:40	131.2	

Project	946621-R038184.00	USGS Sycan
Flightplan	USGS_Sycan_QL1_1560iiS_v2	

Mission Name	S2223546_20211015_F2	**Mission Notes**
Mission Date	10/15/2021	Completed remaining East to West oriented lines near Klamath Falls...full lift.
Aircraft	N840JA	
Pilot	Cameron Stevenson	
Co-Pilot		
Operator	Jonathan Frech	
Co-Operator		
Vendor	NV5 Geospatial	
Base Airport	KBDN	
Departure (Local Time)	8:35:00 AM	
Arrival (Local Time)	2:55:00 PM	

Line	Heading	Start Time (UTC)	Stop Time (UTC)	Speed (kt)	Notes
02125	SW	16:27:25	16:43:11	114.1	
02126	E	16:46:18	16:58:47	143.4	
02127	SW	17:01:49	17:17:20	115.0	
02128	E	17:20:11	17:32:32	143.7	
02129	SW	17:35:43	17:50:55	116.5	
02130	E	17:53:26	18:05:34	145.2	
02131	SW	18:08:37	18:23:42	116.4	
02132	E	18:26:15	18:38:18	145.3	
02133	SW	18:41:25	18:56:22	116.7	
02134	E	18:58:59	19:10:39	148.7	
02135	SW	19:14:04	19:28:57	116.3	
02136	E	19:31:31	19:43:24	145.1	
02137	SW	19:46:45	20:01:13	118.7	
02138	E	20:03:52	20:15:32	146.7	
02139	SW	20:18:48	20:33:05	119.3	
02140	E	20:35:49	20:47:27	146.0	
02141	SW	20:51:07	21:05:24	118.7	
x-line	N	21:07:42	21:12:18	142.8	crossline

Project	946621-R038184.00	USGS Sycan
Flightplan	USGS_Sycan_QL1_1560iiS_v2	

Mission Name	S2223546_20211016_F1	**Mission Notes**
Mission Date	10/16/2021	Manual entry. .rpp was not accepted by Neus. See FFM.
Aircraft	N840JA	
Pilot	Cameron Stevenson	
Co-Pilot		
Operator	Jonathan Frech	
Co-Operator		
Vendor	NV5 Geospatial	
Base Airport	KBDN	
Departure (Local Time)	8:35:00 AM	
Arrival (Local Time)	2:55:00 PM	

Line	Heading	Start Time (UTC)	Stop Time (UTC)	Speed (kt)	Notes
02250	S	12:00:00	12:30:00		manual entry to nexus
02251	S	12:00:00	12:30:00		manual entry to nexus
02252	S	12:00:00	12:30:00		manual entry to nexus
02253	S	12:00:00	12:30:00		manual entry to nexus

Project	946621-R038184.00	USGS Sycan
Flightplan	USGS_Sycan_QL1_1560iiS_v2	

Mission Name	S2223546_20211016_F2	**Mission Notes**
Mission Date	10/16/2021	Plan was to attempt higher elevation lines first but had to move around due to Goose MOA going hot, all remaining lines in southern block are now snow free. Had some troubleshooting and licensing issues we had to work through in the AM but finally got a decent lift in.
Aircraft	N840JA	
Pilot	Cameron Stevenson	
Co-Pilot		
Operator	Jonathan Frech	
Co-Operator		
Vendor	NV5 Geospatial	
Base Airport	KBDN	
Departure (Local Time)	10:55:00 AM	
Arrival (Local Time)	5:25:00 PM	

Line	Heading	Start Time (UTC)	Stop Time (UTC)	Speed (kt)	Notes
02305	S	20:48:22	20:54:14	121.8	
02304	N	20:57:22	21:02:06	151.2	
02303	S	21:05:41	21:11:59	122.2	
02302	N	21:14:40	21:20:30	151.7	
02301	S	21:23:57	21:31:40	120.2	
02300	N	21:34:35	21:41:08	146.5	
02299	S	21:44:48	21:53:37	117.0	
02298	N	21:56:28	22:07:14	147.4	
02297	S	22:10:37	22:24:12	117.1	
02296	N	22:27:14	22:38:08	146.3	
02295	S	22:41:19	22:54:14	123.5	
02294	N	22:56:51	23:07:48	145.6	
02293	S	23:10:43	23:23:41	123.0	
x-line	E	23:25:59	23:29:19	138.9	crossline
02292	N	23:35:34	23:46:31	146.0	

Project	946621-R038184.00	USGS Sycan
Flightplan	USGS_Sycan_QL1_1560iiS_v2	

Mission Name	S2223546_20211017_F1	**Mission Notes**
Mission Date	10/17/2021	Did a lift near Burns instead of K falls to avoid hot MOA today
Aircraft	N840JA	
Pilot	Cameron Stevenson	
Co-Pilot		
Operator	Jonathan Frech	
Co-Operator		
Vendor	NV5 Geospatial	
Base Airport	KBDN	
Departure (Local Time)	8:15:00 AM	
Arrival (Local Time)	2:30:00 PM	

Line	Heading	Start Time (UTC)	Stop Time (UTC)	Speed (kt)	Notes
02159	SW	16:09:11	16:19:41	117.7	
02160	E	16:23:02	16:31:48	141.3	
02161	SW	16:34:37	16:44:54	123.5	
02162	E	16:47:37	16:56:56	145.8	
02163	SW	17:00:00	17:10:52	125.2	
02164	E	17:13:48	17:23:13	145.0	
02165	SW	17:26:31	17:37:34	125.9	
02166	E	17:40:46	17:50:28	146.0	
02167	SW	17:53:43	18:05:02	125.4	
02168	E	18:07:36	18:17:15	147.7	
02169	SW	18:20:25	18:32:03	122.8	
02170	E	18:34:40	18:44:42	148.5	
02171	SW	18:47:52	19:00:18	119.7	
02172	E	19:02:35	19:12:35	148.9	
02173	SW	19:15:30	19:28:21	115.7	
02174	E	19:31:11	19:41:23	146.1	
02175	SW	19:44:14	19:55:41	130.0	
02176	E	19:58:36	20:08:44	146.3	
02177	SW	20:11:51	20:22:25	135.6	
02178	E	20:24:30	20:33:35	151.4	
02179	SW	20:36:31	20:46:43	133.8	
x-line	N	20:49:10	20:53:40	176.7	crossline

Project	946621-R038184.00	USGS Sycan
Flightplan	USGS_Sycan_QL1_1560iiS_v2	

Mission Name	S2223546_20211019_F1	**Mission Notes**
Mission Date	10/19/2021	Finished AOIs near Burns, OR. very little snow on a handful of lines
Aircraft	N840JA	
Pilot	Cameron Stevenson	
Co-Pilot		
Operator	Jonathan Frech	
Co-Operator		
Vendor	NV5 Geospatial	
Base Airport	KBDN	
Departure (Local Time)	8:00:00 AM	
Arrival (Local Time)	1:00:00 PM	

Line	Heading	Start Time (UTC)	Stop Time (UTC)	Speed (kt)	Notes
02180	E	15:53:51	15:59:44	129.7	
02181	SW	16:02:19	16:07:49	138.8	
02182	E	16:10:29	16:16:19	130.8	
02183	SW	16:18:48	16:24:01	140.0	
02184	E	16:29:57	16:30:55	136.9	
x-line	N	16:33:27	16:35:15	151.3	crossline
02218	E	16:52:10	16:56:33	130.9	
02217	SW	16:59:34	17:03:35	144.0	
02216	E	17:06:56	17:11:24	131.9	
02215	SW	17:16:08	17:20:26	145.7	
02214	E	17:23:49	17:28:35	131.5	
02213	SW	17:31:31	17:35:58	145.8	
02212	E	17:39:36	17:44:36	131.9	
02211	SW	17:47:27	17:52:01	144.4	
02210	E	17:55:11	18:00:08	133.7	
02209	SW	18:02:56	18:07:36	141.7	
02208	E	18:10:52	18:15:46	135.0	
02207	SW	18:18:38	18:23:17	141.9	
02206	E	18:26:36	18:31:16	137.5	
02205	SW	18:34:28	18:38:16	140.3	
02204	E	18:41:46	18:45:26	137.7	
02203	SW	18:48:54	18:50:56	141.6	
xline	S	18:53:01	18:57:52	120.9	crossline

Project	946621-R038184.00	USGS Sycan
Flightplan	USGS_Sycan_QL1_1560iiS_v2	

Mission Name	S2224046_20220720_F1	**Mission Notes**
Mission Date	7/20/2022	Jamon and I wrapped up our final rotation day with a good lift on the USGS Western Central Sycan QL1 block. The MOA was hot today but did not hinder our collection mission. The remaining lines run into the active MOA, so this might require coordination from the incoming crew; we will be sure to brief them on details. The USGS QL1 project should be completed with two more lifts.
Aircraft	N473TW	
Pilot	Jamon Neilson	
Co-Pilot		
Operator	Collier Williams	
Co-Operator		
Vendor	NV5 Geospatial	
Base Airport	KMFR	
Departure (Local Time)	9:45:00 AM	
Arrival (Local Time)	2:53:00 PM	

Line	Heading	Start Time (UTC)	Stop Time (UTC)	Speed (kt)	Notes
02292	S	17:30:01	17:46:19	98.4	
02290	N	17:48:45	17:58:55	157.3	
02291	S	18:01:32	18:13:53	130.3	
02289	N	18:16:14	18:27:11	144.7	
02288	S	18:30:49	18:43:03	129.5	
02287	N	18:45:24	18:55:35	153.2	
02286	S	18:58:30	19:10:01	135.3	
02285	N	19:12:27	19:23:18	144.2	
02284	S	19:26:25	19:37:50	135.0	
02283	N	19:40:11	19:49:54	158.6	
02282	S	19:52:53	20:04:00	140.8	
02281	N	20:06:29	20:16:59	149.3	
02280	S	20:20:20	20:31:47	136.6	
02279	N	20:34:21	20:45:14	144.2	
02278	S	20:48:16	20:59:58	134.2	
02278	E	21:02:27	21:05:37	166.9	Crossline

Project	946621-R038184.00	USGS Sycan
Flightplan	USGS_Sycan_QL1_1560iiS_v2	

Mission Name	S2224046_20220721_F1	**Mission Notes**
Mission Date	7/21/2022	
Aircraft	N473TW	ended flight early for turbulence
Pilot	Zach Leitch	
Co-Pilot		
Operator	Jonathan Frech	
Co-Operator		
Vendor	NV5 Geospatial	
Base Airport	KMFR	
Departure (Local Time)	10:30:00 AM	
Arrival (Local Time)	3:20:00 PM	

Line	Heading	Start Time (UTC)	Stop Time (UTC)	Speed (kt)	Notes
02254	N	18:16:31	18:28:04	146.1	
02255	S	18:29:28	18:42:12	135.9	
02256	N	18:43:49	18:55:47	149.5	
02257	S	18:56:57	19:10:10	136.6	
02258	N	19:11:22	19:23:19	151.1	
02259	S	19:24:33	19:37:46	141.1	
02260	N	19:39:04	19:52:00	145.1	
02261	S	19:53:19	20:06:51	139.8	
02262	N	20:08:09	20:21:25	143.5	
02263	S	20:22:50	20:36:35	138.2	
02264	N	20:37:48	20:51:24	142.6	
02265	S	20:53:13	21:07:04	141.7	
02266	N	21:08:30	21:22:45	139.7	
xline	SW	21:25:53	21:29:24	114.1	crossline

Project	946621-R038184.00	USGS Sycan
Flightplan	USGS_Sycan_QL1_1560iiS_v2	

Mission Name	S2224046_20220722_F1	**Mission Notes**
Mission Date	7/22/2022	finished Sycan lines and Green Diamond Refly lines, no turb
Aircraft	N473TW	
Pilot	Zach Leitch	
Co-Pilot		
Operator	Jonathan Frech	
Co-Operator		
Vendor	NV5 Geospatial	
Base Airport	KMFR	
Departure (Local Time)	7:30:00 AM	
Arrival (Local Time)	12:50:00 PM	

Line	Heading	Start Time (UTC)	Stop Time (UTC)	Speed (kt)	Notes
00074	E	15:07:18	15:12:27	146.7	Green Diamond Project
00075	SW	15:14:24	15:20:27	124.1	Green Diamond Project
00076	E	15:22:13	15:27:18	145.8	Green Diamond Project
00077	SW	15:28:43	15:34:16	126.6	Green Diamond Project
00078	E	15:35:31	15:40:18	144.9	Green Diamond Project
00079	SW	15:41:57	15:47:26	126.1	Green Diamond Project
xline	N	15:49:25	15:52:00	161.1	crossline
02277	S	16:05:25	16:17:08	133.9	
02276	N	16:18:13	16:28:57	146.1	
02275	S	16:30:18	16:41:51	135.3	
02274	N	16:42:52	16:47:20	146.2	
02274	NE	16:53:26	16:53:31	185.4	
02274	S	16:54:58	17:06:36	134.3	
02273	N	17:07:24	17:19:45	140.7	line 2273
02272	S	17:21:06	17:32:53	133.3	
02271	N	17:36:58	17:50:27	143.9	
02270	S	17:51:46	18:05:38	139.7	
02269	N	18:07:08	18:21:01	143.2	
02268	S	18:22:14	18:36:32	139.2	
02267	N	18:37:37	18:51:32	143.2	
xline	SW	18:55:45	18:58:59	123.3	crossline

Project	946621-R038184.00	USGS Sycan
Flightplan	USGSWestCentSycan_1560ii_QL2	

Mission Name	S2224046_20220719_F1
Mission Date	7/19/2022
Aircraft	N473TW
Pilot	Jamon Neilson
Co-Pilot	
Operator	Collier Williams
Co-Operator	
Vendor	NV5 Geospatial
Base Airport	KLMT
Departure (Local Time)	9:10:00 AM
Arrival (Local Time)	1:15:00 PM

Mission Notes

We finished USGS West Central Sycan QL2 after finishing the Green Diamond project. We had issues getting the QL1 flight plan to work. AW sent another version we will try in the AM.

Line	Heading	Start Time (UTC)	Stop Time (UTC)	Speed (kt)	Notes
00001	SW	18:39:38	18:43:32	134.6	
00002	E	18:46:10	18:49:58	148.8	
00003	SW	18:53:58	18:58:26	134.3	
00004	E	19:01:30	19:05:31	158.9	
00005	SW	19:08:35	19:13:19	139.1	
00006	E	19:15:40	19:19:45	163.0	
00007	SW	19:22:36	19:27:18	140.8	
00008	E	19:29:58	19:34:14	155.1	
00009	SW	19:37:29	19:40:19	135.0	
00010	E	19:42:44	19:44:14	149.5	
00010	N	19:45:57	19:49:02	171.0	crossline