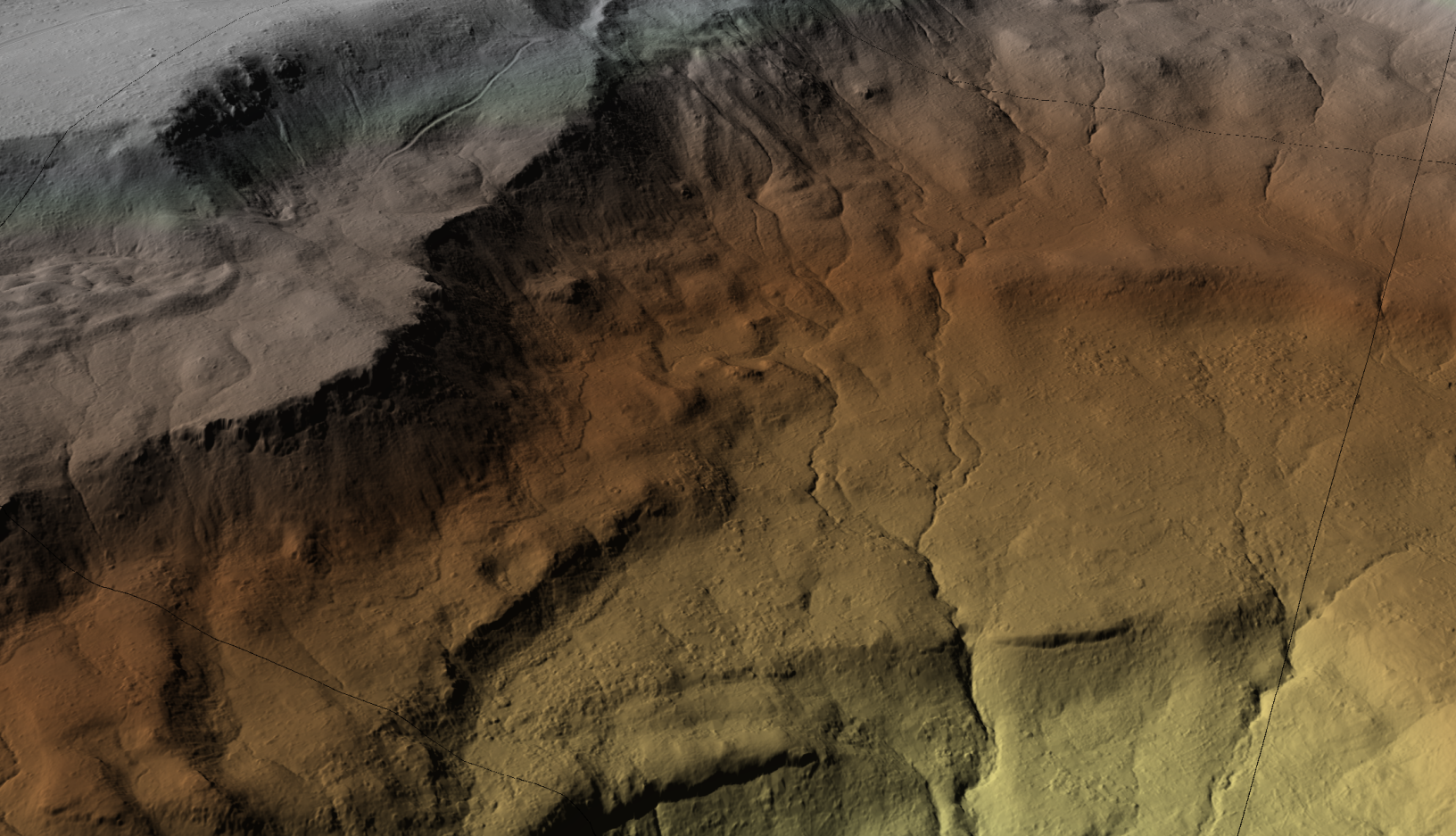


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WA_EASTERNCASCADES_2019_B19 LIDAR PROCESSING REPORT

Work Package: 182977
Work Unit: 218684

2021

Submitted: September 30, 2021

Prepared for:



Prepared by:



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1. Summary / Scope

1.1. Summary

This report contains a summary of the WA_EasternCascades_2019_B19, Work Unit 218684 lidar acquisition task order, issued by USGS under their Contract G16PC00016 on September 16, 2019. The task order yielded a project area covering approximately 1,799 square miles over Washington. 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 / m ²	1828-2085 m	58°	55%	≤ 10 cm

1.3. Coverage

The project boundary covers approximately 1,799 square miles over Washington. Project extents are shown in Figure 1.

1.4. Duration

Lidar data was acquired from October 3, 2019 to August 22, 2020 in 29 total lifts. See “Section: 2.4. Time Period” for more details.

1.5. Issues

There were no major issues to report for this project.

WA_EasternCascades_2019_B19 Work Unit 218684 Projected Coordinate System: UTM Zone 10N Horizontal Datum: NAD1983 (2011) Vertical Datum: NAVD88 (GEOID 12b) Units: Meters	
Lidar Point Cloud	Classified Point Cloud in .LAS 1.4 format
Rasters	<ul style="list-style-type: none"> • 0.5-meter Hydro-flattened Bare Earth Digital Elevation Model (DEM) in GeoTIFF format • 0.5-meter Intensity images in GeoTIFF format
Vectors	Shapefiles (*.shp) <ul style="list-style-type: none"> • Project Boundary • Lidar Tile Index • Calibration and QC Checkpoints (NVA/VVA) Geodatabase (*.gdb) <ul style="list-style-type: none"> • Continuous Hydro-flattened Breaklines
Reports	Reports in PDF format <ul style="list-style-type: none"> • Focus on Delivery • Processing Report • Focus on Accuracy
Metadata	XML Files (*.xml) <ul style="list-style-type: none"> • Breaklines • Classified Point Cloud • DEM • Intensity Imagery

WA_EasternCascades_2019_B19 Work Unit 218684 Boundary

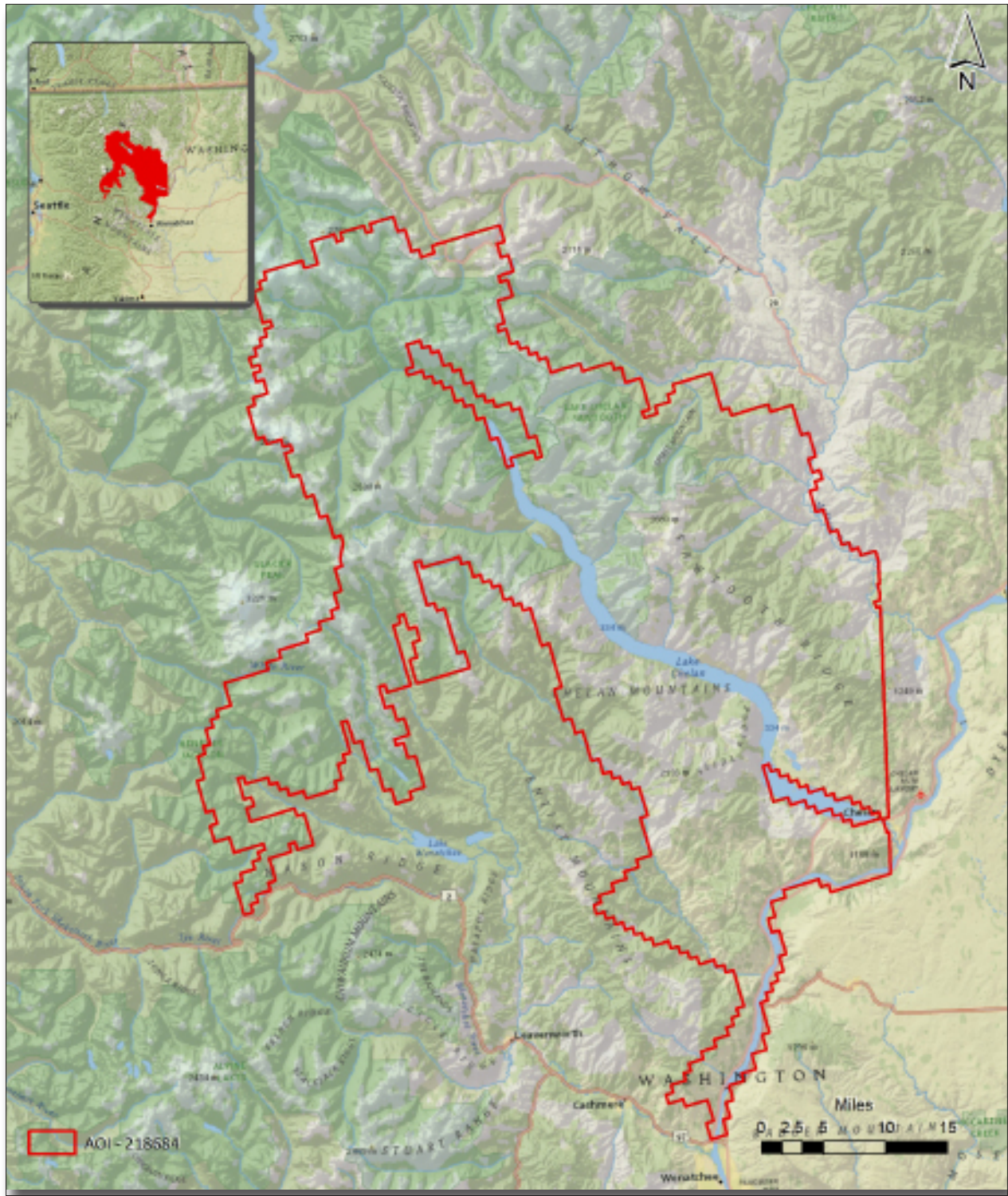


Figure 1. Work Unit Boundary

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 a Riegl VQ1560i lidar sensor (Figure 2), sensor number 3070 for data acquisition.

The Riegl 1560i system has a laser pulse repetition rate of up to 2 MHz resulting in more than 1.3 million measurements per second. The system utilizes a Multi-Pulse in the Air option (MPIA). The sensor is also equipped with the ability to measure up to an unlimited number of targets per pulse from the laser.

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 VQ1560i (3070)
Terrain and Aircraft Scanner	Flying Height	1828 m
	Recommended Ground Speed	120 kts
Scanner	Field of View	58°
	Scan Rate Setting Used	99 lines per second
Laser	Laser Pulse Rate Used	2 x 500 kHz
	Multi Pulse in Air Mode	yes
Coverage	Full Swath Width	2048 m
	Line Spacing	920 m
Point Spacing and Density	Aggregate Pulse Spacing	0.31 m
	Average Point Density	2 x 5.27 pts / m ²

Figure 2. Riegl V1560i Lidar Sensor



2.3. Aircraft

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

Lidar Collection Planes

- Cessna 208B Grand Caravan, Tail Number: N256DG

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 lidar systems. Some of NV5 Geospatial's operating aircraft can be seen in Figure 3 below.

Figure 3. Some of NV5 Geospatial's Planes



2.4. Time Period

Project specific flights were conducted between October 3, 2019 and August 22, 2020. Twenty-nine aircraft lifts were completed. Accomplished lifts are listed below.

- 10032019A (SN3070,N256DG)
- 10092019A (SN3070,N256DG)
- 10102019A (SN3070,N256DG)
- 10172019A (SN3070,N256DG)
- 08032020A (SN3070,N256DG)
- 08042020A (SN3070,N256DG)
- 08052020A (SN3070,N256DG)
- 08062020A (SN3070,N256DG)
- 08072020A1 (SN3070,N256DG)
- 08072020A2 (SN3070,N256DG)
- 08082020A (SN3070,N256DG)
- 08082020B (SN3070,N256DG)
- 08092020A1 (SN3070,N256DG)
- 08092020A2 (SN3070,N256DG)
- 08102020A (SN3070,N256DG)
- 08112020A (SN3070,N256DG)
- 08132020A1 (SN3070,N256DG)
- 08132020A2 (SN3070,N256DG)
- 08142020A1 (SN3070,N256DG)
- 08142020A2 (SN3070,N256DG)
- 08152020A1 (SN3070,N256DG)
- 08152020A2 (SN3070,N256DG)
- 08152020B (SN3070,N256DG)
- 08162020A1 (SN3070,N256DG)
- 08162020A2 (SN3070,N256DG)
- 08172020A (SN3070,N256DG)
- 08182020A (SN3070,N256DG)
- 08192020A (SN3070,N256DG)
- 08222020A (SN3070,N256DG)

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).

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
RiPROCESS	1.8.6
Applanix + POSPac	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 the USGS Version 1.3 specifications 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

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 TerraScan macro functionality. A buffer of 3 feet 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

Class 2 lidar was used to create a bare earth surface model. The surface model was then used to heads-up digitize 2D breaklines of Inland Streams and Rivers with a 100 foot nominal width and Inland Ponds and Lakes of 2 acres or greater surface area.

Elevation values were assigned to all Inland Ponds and Lakes, Inland Pond and Lake Islands, Inland Streams and Rivers and Inland Stream and River Islands using NV5 Geospatial's proprietary software.

All ground (ASPRS Class 2) lidar data inside of the collected inland breaklines were then classified to water (ASPRS Class 9) using TerraScan macro functionality. A buffer of 3 feet was also used around each hydro flattened feature. These points were moved from ground (ASPRS Class 2) to Ignored Ground (ASPRS Class 20).

The breakline files were then translated to Esri file geodatabase format using Esri conversion tools.

Breaklines are reviewed against lidar intensity imagery to verify completeness of capture. All breaklines are then compared to TINs (triangular irregular networks) created from ground only points prior to water classification. The horizontal placement of breaklines is compared to terrain features and the breakline elevations are compared to lidar elevations 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 variance is reviewed, all breaklines are reviewed for topological consistency and data integrity using a combination of Esri Data Reviewer tools and proprietary tools.

3.6. Hydro-Flattened Raster DEM Processing

Class 2 lidar in conjunction with the hydro breaklines were used to create a 0.5-meter Raster DEM. Using automated scripting routines within proprietary software, a GeoTIFF file was created for each tile. Each surface is reviewed using Global Mapper to check for any surface anomalies or incorrect elevations found within the surface.

3.7. Intensity Image Processing

GeoCue software was used to create the deliverable intensity images. All withheld points were ignored during this process. This helps to ensure a more aesthetically pleasing image. The GeoCue software was then used to verify full project coverage as well. GeoTIFF files with a cell size of 0.5-meter were then provided as the deliverable for this dataset requirement.

WA_EasternCascades_2019_B19 Work Unit 218684 Tile Layout

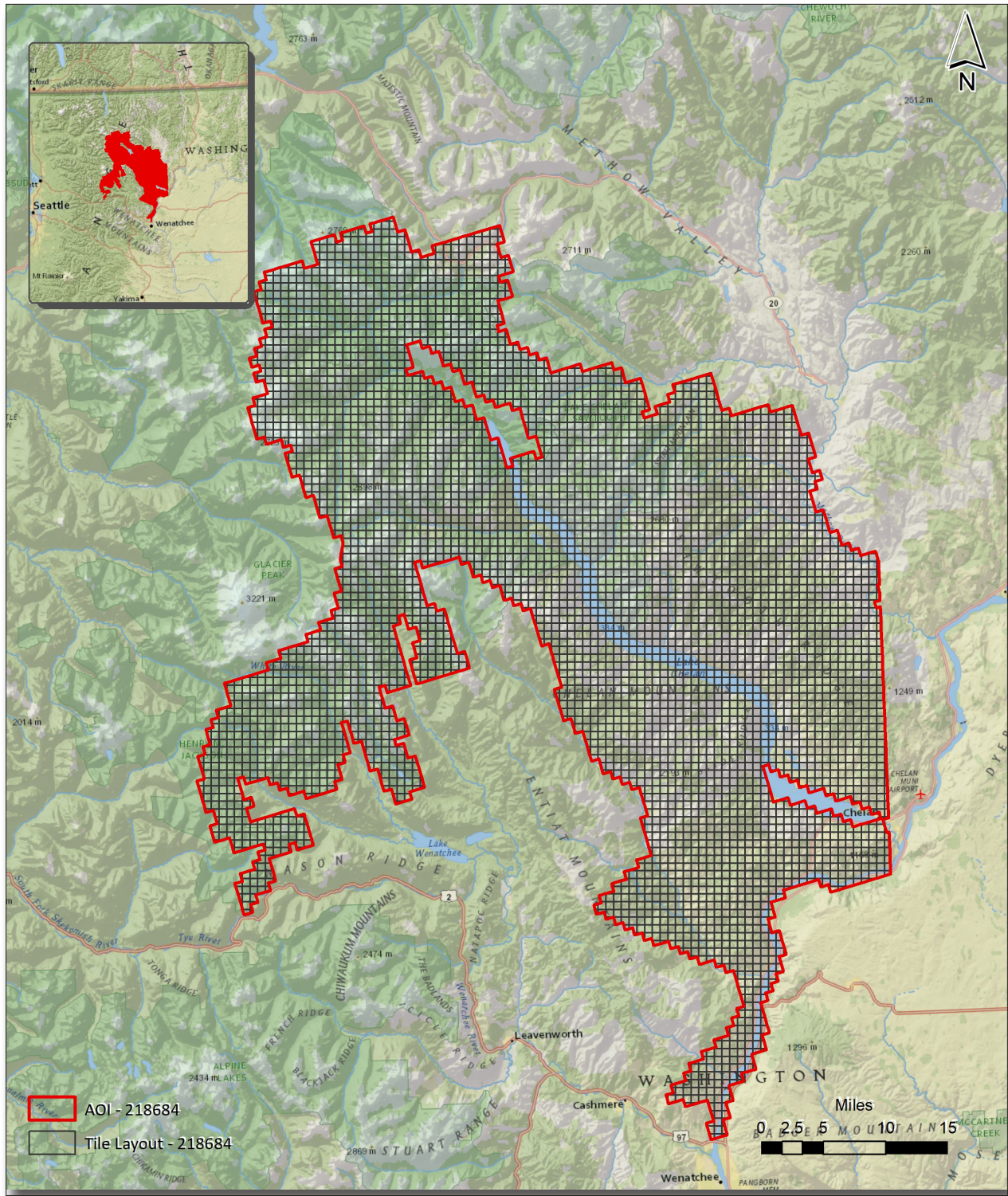


Figure 4. Lidar Tile Layout

4. Project Coverage Verification

Coverage verification was performed by comparing coverage of processed .LAS files captured during project collection to generate project shape files depicting boundaries of specified project areas. Please refer to Figure 5.

WA_EasternCascades_2019_B19 Work Unit 218684 Lidar Coverage

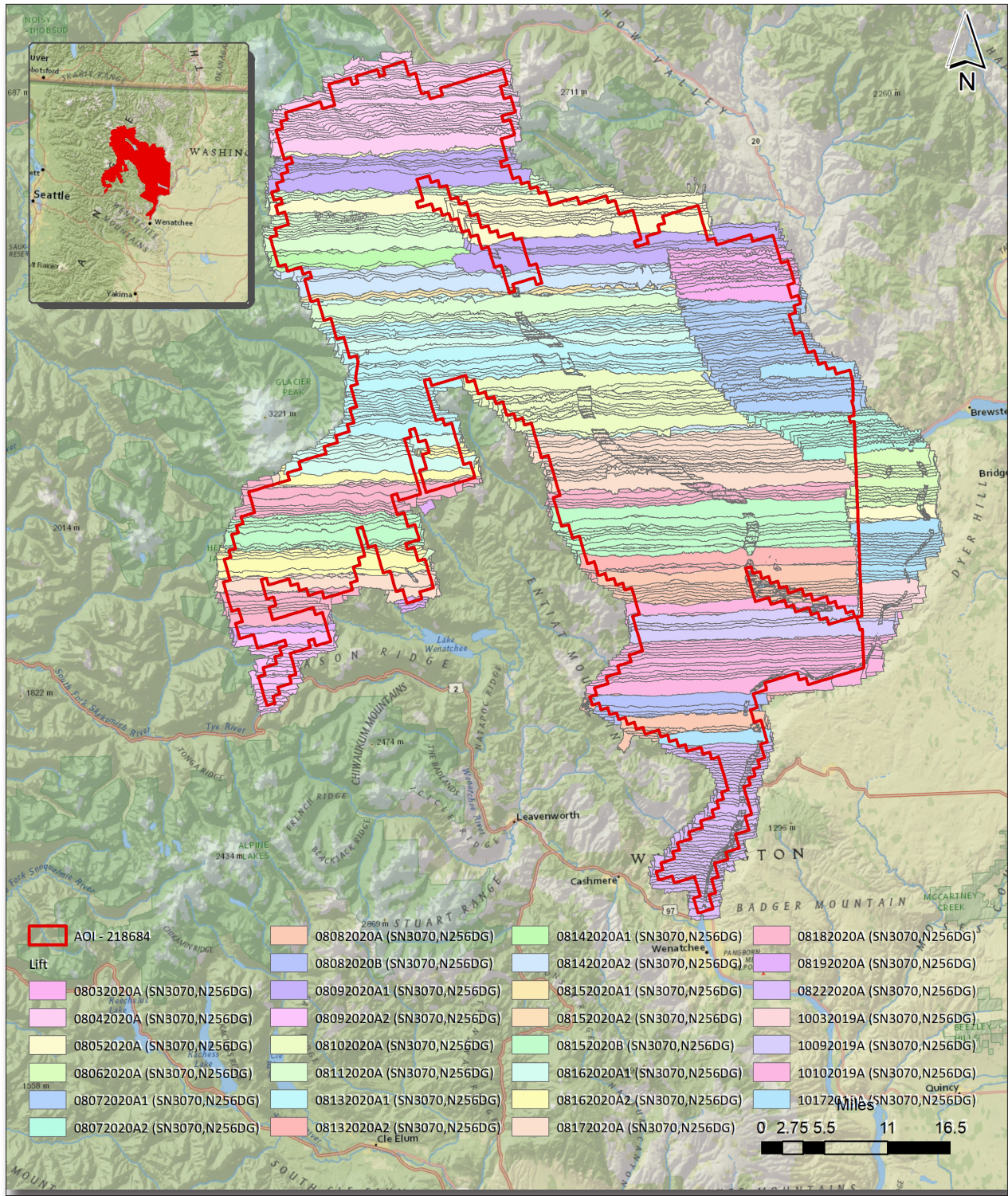


Figure 5. Lidar Coverage

5. Geometric Accuracy

5.1. Horizontal Accuracy

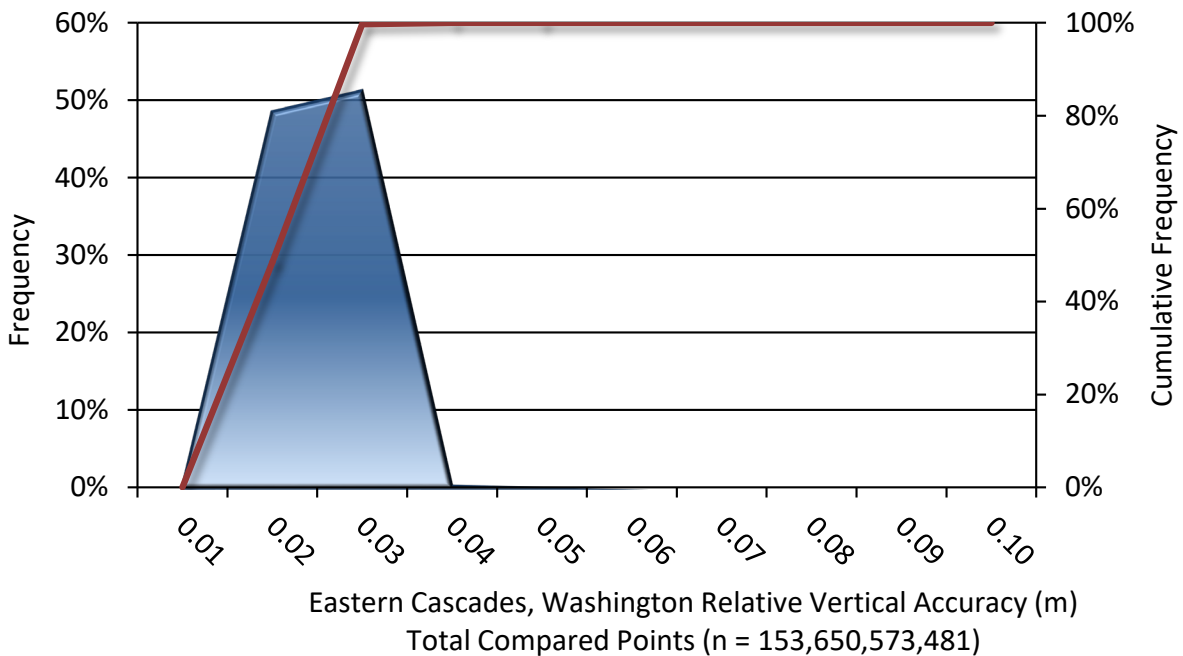
Lidar horizontal accuracy is a function of Global Navigation Satellite System (GNSS) derived positional error, flying altitude, and INS derived attitude error. The obtained $RMSE_r$ value is multiplied by a conversion factor of 1.7308 to yield the horizontal component of the National Standards for Spatial 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 2000 meters, an IMU error of 0.002 decimal degrees, and a GNSS positional error of 0.015 meters, this project was compiled to meet 0.22 meter horizontal accuracy at the 95% confidence level. A summary is shown below.

Horizontal Accuracy	
$RMSE_r$	0.13 m
	0.41 ft
ACC_r	0.22 m
	0.71 ft

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 Project Name Lidar project was 0.061 feet (0.019 meters). A summary is shown below.

Relative Vertical Accuracy	
Sample	1187 flight line surfaces
Average	0.061 ft
	0.019 m
Median	0.067 ft
	0.020 m
RMSE	0.066 ft
	0.020 m
Standard Deviation (1σ)	0.013 ft
	0.004 m
1.96 σ	0.025 ft
	0.008 m



6. Ground Control and Check Point Collection

Quantum Spatial completed a field survey of 523 ground control (calibration) points along with 225 blind QA points in Non-Vegetated and Vegetated land cover classifications as an independent test of the accuracy of this project.

A combination of precise GPS surveying methods, including static and RTK observations were used to establish the 3D position of ground calibration points and QA points for the point classes above. GPS was not an appropriate methodology for surveying in the forested areas during the leaf-on conditions for the actual field survey (which was accomplished after the LiDAR acquisition). Therefore the 3D positions for the forested points were acquired using a GPS-derived offset point located out in the open near the forested area, and using precise offset surveying techniques to derive the 3D position of the forested point from the open control point. The explicit goal for these surveys was to develop 3D positions that were three times greater than the accuracy requirement for the elevation surface. In this case of the blind QA points the goal was a positional accuracy of 5 cm in terms of the RMSE.

The required accuracy testing was performed on the LiDAR dataset (both the LiDAR point cloud and derived DEM's) according to the USGS LiDAR Base Specification Version 1.3.

6.1. Calibration Control Point Testing

Figure 6 shows the location of each bare earth calibration point for the project area. TerraScan was used to perform a quality assurance check using the LiDAR bare earth calibration points. The results of the surface calibration are not an independent assessment of the accuracy of these project deliverables, but the statistical results do provide additional feedback as to the overall quality of the elevation surface.

6.2. Point Cloud Testing

The project specifications require that only Non-Vegetated Vertical Accuracy (NVA) be computed for raw lidar point cloud swath files. The required accuracy (ACCz) is: 19.6 cm at a 95% confidence level, derived according to NSSDA, i.e., based on RMSE of 10 cm in the “bare earth” and “urban” land cover classes. The NVA was tested with 131 checkpoints located in bare earth and urban (non-vegetated) areas. These check points were not used in the calibration or post processing of the lidar point cloud data. The checkpoints were distributed throughout the project area and were surveyed using GPS techniques. See survey report for additional survey methodologies.

Elevations from the unclassified lidar surface were measured for the x,y location of each check point. Elevations interpolated from the lidar surface were then compared to the elevation values of the surveyed control points. AccuracyZ has been tested to meet 19.6 cm or better Non-Vegetated Vertical Accuracy at 95% confidence level using $RMSE(z) \times 1.9600$ as defined by the National Standards for Spatial Data Accuracy (NSSDA); assessed and reported using National Digital Elevation Program (NDEP)/ASPRS Guidelines.

6.3. Digital Elevation Model (DEM) Testing

The project specifications require the accuracy (ACCz) of the derived DEM be calculated and reported in two ways:

1. The required NVA is: 19.6 cm at a 95% confidence level, derived according to NSSDA, i.e., based on RMSE of 10 cm in the “bare earth” and “urban” land cover classes. This is a required accuracy. The NVA was tested with 131 checkpoints located in bare earth and urban (non-vegetated) areas. See Figure 7.

2. Vegetated Vertical Accuracy (VVA): VVA shall be reported for “brushlands/low trees” and “tall weeds/crops” land cover classes. The target VVA is: 29.4 cm at the 95th percentile, derived according to ASPRS Guidelines, Vertical Accuracy Reporting for Lidar Data, i.e., based on the 95th percentile error in all vegetated land cover classes combined. This is a target accuracy. The VVA was tested with 94 checkpoints located in tall weeds/crops and brushlands/low trees (vegetated) areas. The checkpoints were distributed throughout the project area and were surveyed using GPS techniques. See Figure 8.

AccuracyZ has been tested to meet 19.6 cm or better Non-Vegetated Vertical Accuracy at 95% confidence level using $RMSE(z) \times 1.9600$ as defined by the National Standards for Spatial Data Accuracy (NSSDA); assessed and reported using National Digital Elevation Program (NDEP)/ASRPS Guidelines.

A brief summary of results are listed below.

	Target	Measured	Point Count
Raw NVA	0.196 m	0.0864 m	131
NVA	0.196 m	0.0860 m	131
VVA	0.294 m	0.2521	94

WA_EasternCascades_2019_B19 UTM 10 Calibration Points

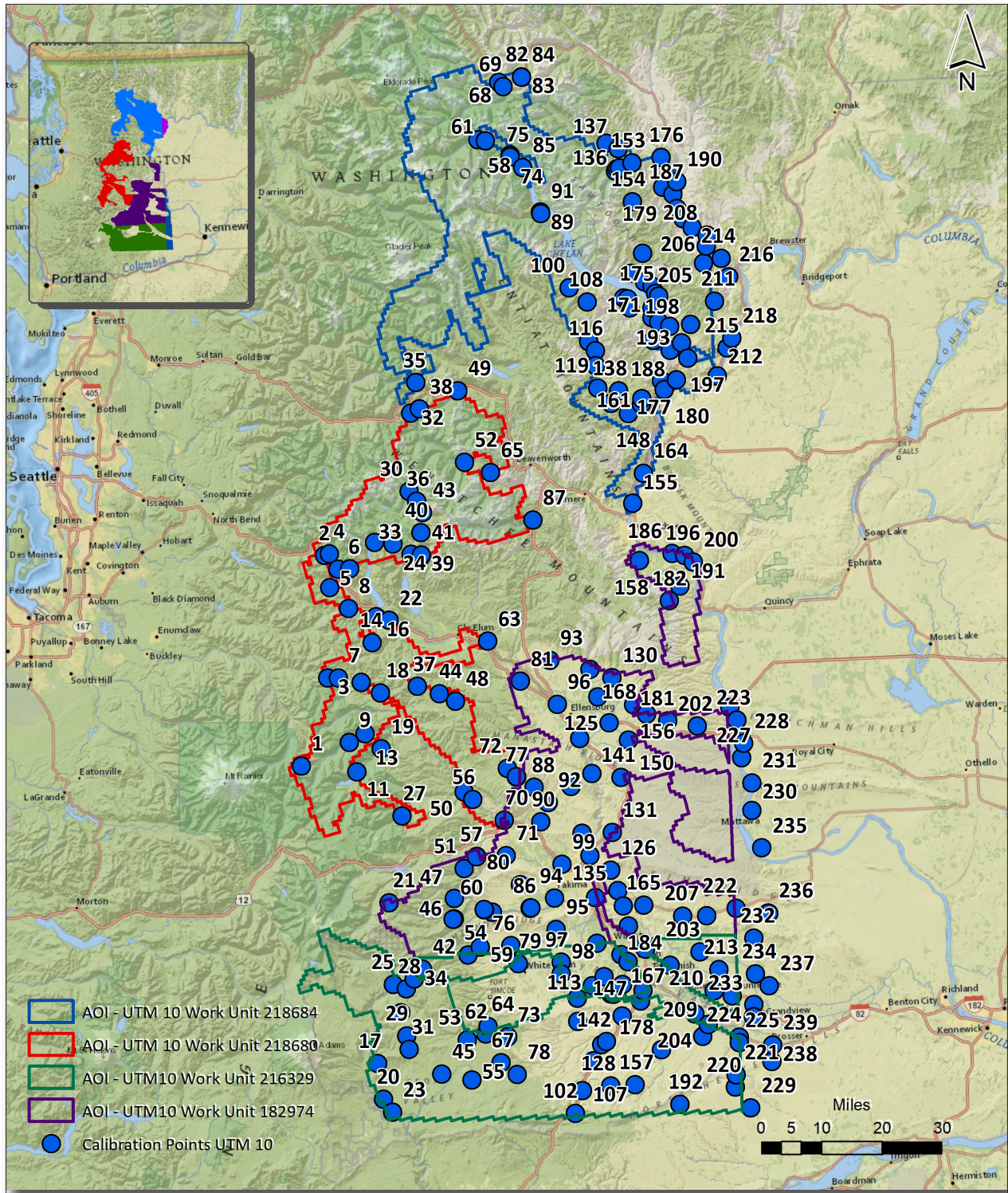


Figure 6. Calibration Control Point Locations

WA_EasternCascades_2019_B19 UTM 10 NVA Points

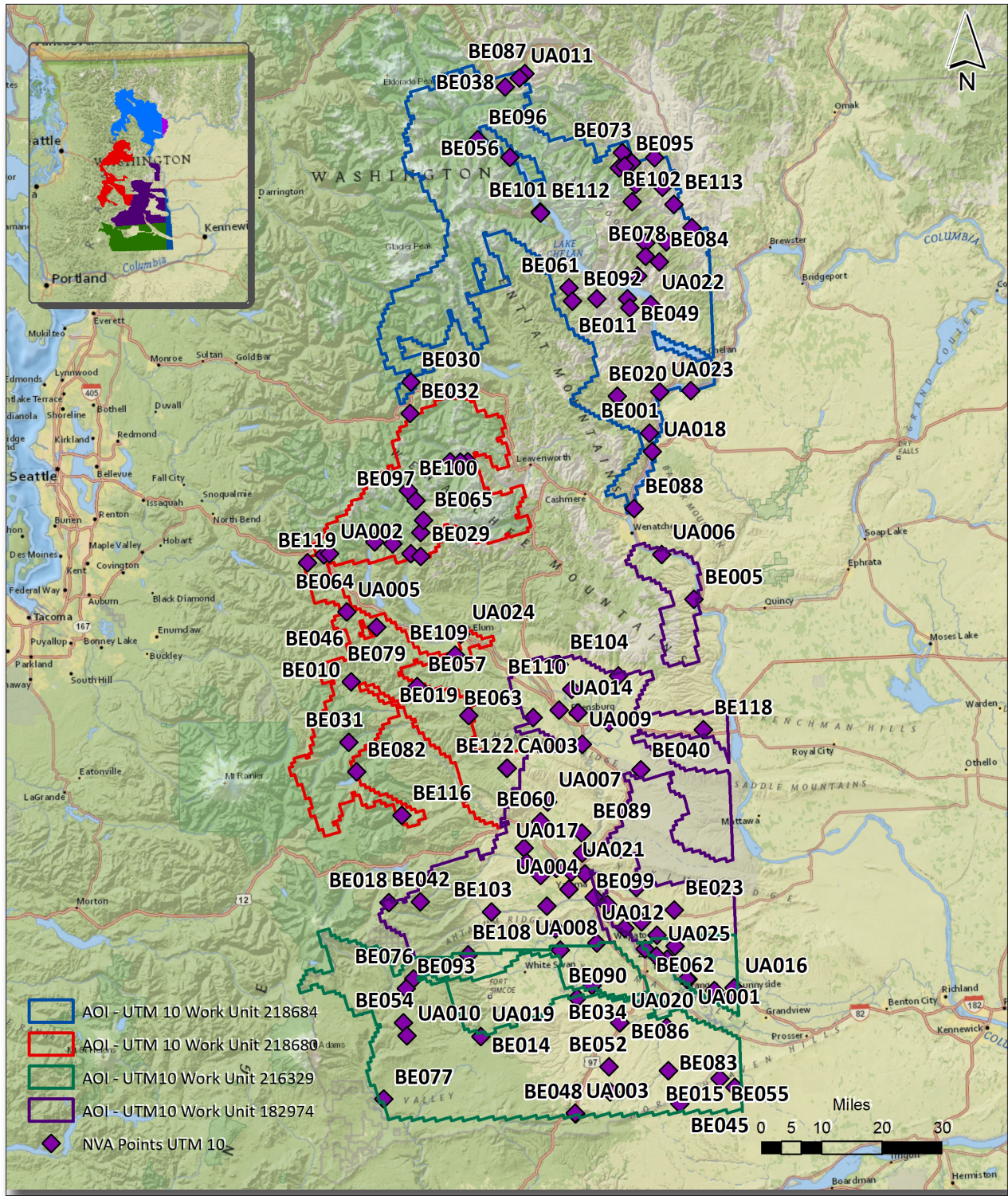


Figure 7. QC Checkpoint Locations - NVA

WA_EasternCascades_2019_B19

UTM 10 VVA Points

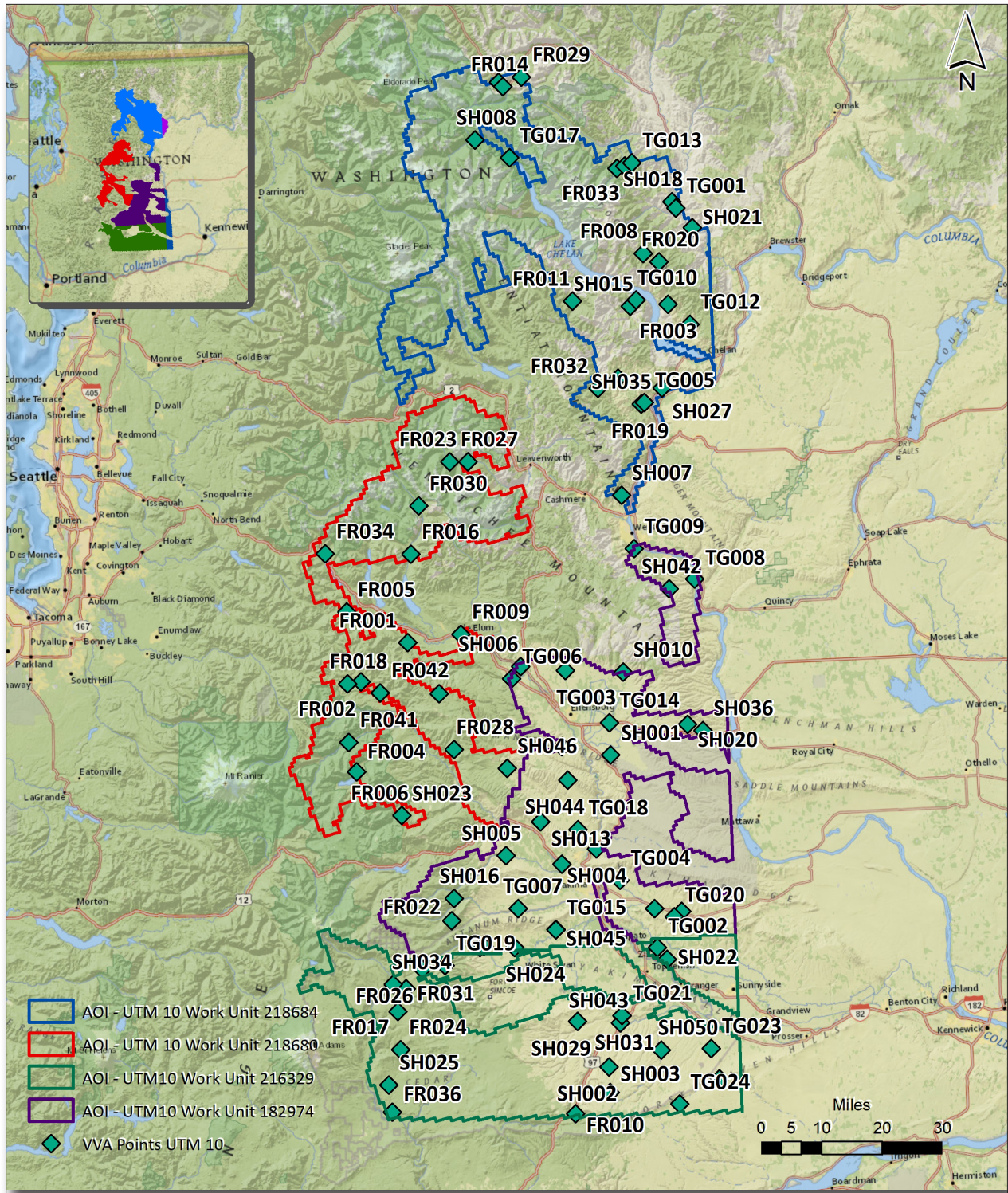


Figure 8. QC Checkpoint Locations - VVA

Project Report Appendices

The following section contains the appendices as listed in the **WA_EasternCascades_2019_B19 Lidar Project Report**.

Appendix A

Flight Logs

Julian Day 307 Flt A

LIDAR Flight Log



Date	November 3 2019	Aircraft	C-FVZM
Project	3183_QSI_CascadeCounties		
Location	Yakima, WA	Pilot	N. Emson
Mission Objective	Operator J. Grayson		

System	1560i
Unit	38
IMU	Applanix AP50
GPS Rx	Trimble
Scanner 1 Drive	4
Scanner 2 Drive	5

Additional Notes

Aircraft Block Time			
Engine On	17:19	Ramp Out	Takeoff 17:38
Engine Off	23:13	Ramp In	Landing 23:02
Total	5.9 hrs	Total	5.4 hrs

Mission Plan			
AGL Height	2000 m	Pulse Rep Rate	500 kHz
Ground Speed	160 kts	Scan Rate	214 Hz
Laser Current	100 %	FOV	60 Deg's

Static Alignment	GPS Time	
	Start	End
Pre Mission	17:23	17:28
Post Mission	23:06	23:11

Flight Line	LiDAR File Name	Flight Direction	GPS Time		Ln Aborted Time	Date Stamp	ALS Time Stamp	Comments
			Start	End				
00	-		17:56	18:01			-	Figure 8
4001	3819307_01	9°	18:06	18:19			191103_180605	
4002	02	189°	18:23	18:35			182322	
4003	03	9°	18:40	18:54			184023	
4004	04	189°	18:58	19:10			185813	
4005	05	9°	19:15	19:28			191502	
4006	06	189°	19:33	19:45			193308	
4007	07	9°	19:50	20:03			195018	
4008	08	189°	20:07	20:20			200748	
4009	09	9°	20:25	20:40			202515	
4010	10	189°	20:44	20:57			204421	
4011	11	9°	21:01	21:15			210139	
4012	12	189°	21:18	21:31			211845	
4013	13	9°	21:35	21:49			213544	
4014	14	189°	21:54	22:06			215357	

Julian Day 322 Flt A

LIDAR Flight Log



Date	November 18, 2019	Aircraft	CFVZM
Project	3183_QSI_CascadeCounties	Pilot	J. Mathieson
Location	Yakima, WA	Operator	B. Eisenbart
Mission Objective			

System	1560i
Unit	38
IMU	Applanix AP50
GPS Rx	Trimble
Scanner 1 Drive	1
Scanner 2 Drive	2

Additional Notes

Aircraft Block Time			
Engine On	16:29	Ramp Out	Takeoff 16:48
Engine Off	21:04	Ramp In	Landing 20:54
Total	4.6 hrs	Total	4.1 hrs

Mission Plan			
AGL Height	2000 m	Pulse Rep Rate	500 kHz
Ground Speed	160 kts	Scan Rate	214 Hz
Laser Current	100 %	FOV	60 Deg's

Static Alignment	GPS Time	
	Pre Mission	Start
Post Mission	16:35	16:40
	20:57	21:02

Flight Line	LiDAR File Name	Flight Direction	GPS Time		Ln Aborted Time	Date Stamp	ALS Time Stamp	Comments
			Start	End				
PPP-8	-		16:57	17:03			-	Figure 8
3032	3819322_01	189°	17:05	17:14		191118_170540		
3031	02	9°	17:17	17:25		171722		
3030	03	189°	17:28	17:37		172848		
3029	04	9°	17:40	17:48		174025		
3028	05	189°	17:52	18:01		175224		
3027	06	9°	18:04	18:11		180401		
3026	07	189°	18:15	18:22		181502		
3025	08	9°	18:26	18:33		182619		
3024	09	189°	18:37	18:44		183701		
3023	10	9°	18:47	18:54		184759		
3022	11	189°	18:58	19:06		185843		
3021	12	9°	19:09	19:16		190914		areas of snow in to the west
X-TIE	13	99°	19:19	19:21		191929		



LIDAR Flight Log

Julian Day 322 Flt A

Date	November 18, 2019	Aircraft	CFVZM
Project	3183_QSI_CascadeCounty	Pilot	J. Mathieson
Location	Yakima, WA	Operator	B. Eisenbart
Mission Objective			

System	1560i
Unit	38
IMU	Applanix AP50
GPS Rx	Trimble
Scanner 1 Drive	1
Scanner 2 Drive	2

Additional Notes

Aircraft Block Time			
Engine On	16:29	Ramp Out	Takeoff 16:48
Engine Off	21:04	Ramp In	Landing 20:54
Total	4.6 hrs	Total	4.1 hrs

Mission Plan			
AGL Height	2000 m	Pulse Rep Rate	500 kHz
Ground Speed	160 kts	Scan Rate	214 Hz
Laser Current	100 %	FOV	60 Deg's

Static Alignment	GPS Time	
	Start	End
Pre Mission	16:35	16:40
Post Mission	20:57	21:02

Flight Line	LiDAR File Name	Flight Direction	GPS Time		Ln Aborted Time	Date Stamp	ALS Time Stamp	Comments
			Start	End				
2111	14	9°	19:27	19:32			192737	Switched to 2300m block and
2110	15	189°	19:36	19:41			193612	changed scanner settings
2109	16	9°	19:44	19:49			194437	
2108	17	189°	19:53	19:59			195326	
2107	18	9°	20:02	20:06			200201	
2106	19	189°	20:10	20:16			201039	
2105	20	9°	20:19	20:24			201925	
2104	21	189°	20:27	20:33			202757	Cloud on south end of line, refly
X-TIE	22	9°	20:37	20:39			203724	
PPP-8	-		20:39	20:45			-	Figure 8

Julian Day 325 Flt A

LIDAR Flight Log



Date	November 21 2019	Aircraft	CFVZM
Project	3183_QSI_CascadeCounties	Pilot	N. Emson
Location	Yakima, WA	Operator	B. Eisenbart
Mission Objective			

System	1560i
Unit	38
IMU	Applanix AP50
GPS Rx	Trimble
Scanner 1 Drive	1
Scanner 2 Drive	2

Additional Notes

Aircraft Block Time		
Engine On	16:35	Ramp Out
Engine Off	23:09	Ramp In
Total	6.6 hrs	Total
		6.1 hrs

Mission Plan		
AGL Height	2000 m	Pulse Rep Rate
Ground Speed	160 kts	Scan Rate
Laser Current	100 %	FOV
		60 Deg's

Static Alignment	GPS Time	
	Start	End
Pre Mission	16:39	16:44
Post Mission	23:02	23:07

Flight Line	LiDAR File Name	Flight Direction	GPS Time		Ln Aborted	Date Stamp	ALS Time Stamp	Comments
			Start	End				
PPP-8	-		17:03	17:08			-	Figure 8
5038	3819325_01	82°	17:10	17:24		191121_171045		
5039	02	262°	17:27	17:40			172701	
5040	03	82°	17:43	17:56			174345	
5041	04	262°	17:59	18:12			175955	
5042	05	82°	18:15	18:29			181547	
5043	06	262°	18:32	18:45			183244	
5044	07	82°	18:48	19:01			184852	
5045	08	262°	19:05	19:18			190520	
5046	09	82°	19:21	19:34			192139	
5047	10	262°	19:37	19:50			193743	
5048	11	82°	19:53	20:06			195356	
5049	12	262°	20:09	20:22			200941	
5050	13	82°	20:26	20:39			202605	
5051	14	262°	20:41	20:55			204154	

Julian Day 325 Flt A

LIDAR Flight Log



Date	November 21 2019	Aircraft	CFVZM
Project	3183_QSI_CascadeCounti	Pilot	N. Emson
Location	Yakima, WA	Operator	B. Eisenbart
Mission Objective			

System	1560i
Unit	38
IMU	Applanix AP50
GPS Rx	Trimble
Scanner 1 Drive	1
Scanner 2 Drive	2

Additional Notes

Aircraft Block Time		
Engine On	16:35	Ramp Out
Engine Off	23:09	Ramp In
Total	6.6 hrs	Total
		6.1 hrs

Mission Plan			
AGL Height	2000 m	Pulse Rep Rate	500 kHz
Ground Speed	160 kts	Scan Rate	214 Hz
Laser Current	100 %	FOV	60 Deg's

Static Alignment	GPS Time	
	Start	End
Pre Mission	16:39	16:44
Post Mission	23:02	23:07

Flight Line	LiDAR File Name	Flight Direction	GPS Time		Ln Aborted Time	Date Stamp	ALS Time Stamp	Comments
			Start	End				
5052	15	82°	20:58	21:11			205829	
5053	16	262°	21:14	21:27			211430	
5054	17	82°	21:32	21:45			213207	
5055	18	262°	21:48	22:01			214833	
5056	19	82°	22:04	22:17			220431	
5057	20	262°	22:21	22:35			222101	
X-TIE	21	352°	22:37	22:40			223714	
PPP-8	-		22:43	22:48			-	Figure 8

Julian Day 326 Flt A

LIDAR Flight Log



Date	November 22, 2019	Aircraft	CFVZM
Project	3183_QSI_CascadeCounties	Pilot	J. Mathieson
Location	Yakima, WA	Operator	B. Eisenbart
Mission Objective			

System	1560i
Unit	38
IMU	Applanix AP50
GPS Rx	Trimble
Scanner 1 Drive	1
Scanner 2 Drive	2

Additional Notes	
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Aircraft Block Time			
Engine On	16:56	Ramp Out	Takeoff 17:12
Engine Off	23:13	Ramp In	Landing 23:04
Total	6.3 hrs	Total	hrs 5.9

Mission Plan			
AGL Height	2000 m	Pulse Rep Rate	500 kHz
Ground Speed	160 kts	Scan Rate	214 Hz
Laser Current	100 %	FOV	60 Deg's

Static Alignment	GPS Time	
	Start	End
Pre Mission	17:00	17:05
Post Mission	23:06	23:11

Flight Line	LiDAR File Name	Flight Direction	GPS Time		Ln Aborted Time	Date Stamp	ALS Time Stamp	Comments
			Start	End				
PPP-8	-		17:23	17:28			-	Figure 8
5058	3819326_01	82°	17:31	17:55	17:39	191122_173138	191122_173138	Clouds on east end of line, refly
4050	02	189°	17:44	17:55			174402	
4051	03	9°	17:58	18:10			175845	
4052	04	189°	18:13	18:25			181336	
4053	05	9°	18:29	18:40			182900	
4054	06	189°	18:43	18:55			184356	
4055	07	9°	18:58	19:10			185851	
4056	08	189°	19:13	19:25			191346	
4057	09	9°	19:28	19:40			192841	
4058	10	189°	19:43	19:55			194335	
4059	11	9°	19:59	20:11			195912	
4060	12	189°	20:14	20:27			201455	
4061	13	9°	20:30	20:43			203029	
4062	14	189°	20:46	20:58			204616	

Julian Day 326 Flt A

LIDAR Flight Log



Date	November 22, 2019	Aircraft	CFVZM
Project	3183_QSI_CascadeCounty	Pilot	J. Mathieson
Location	Yakima, WA	Operator	B. Eisenbart
Mission Objective			

System	1560i
Unit	38
IMU	Applanix AP50
GPS Rx	Trimble
Scanner 1 Drive	1
Scanner 2 Drive	2

Additional Notes

Aircraft Block Time			
Engine On	16:56	Takeoff	17:12
Engine Off	23:13	Landing	23:04
Total	6.3 hrs	Total	5.9 hrs

Mission Plan			
AGL Height	2000 m	Pulse Rep Rate	500 kHz
Ground Speed	160 kts	Scan Rate	214 Hz
Laser Current	100 %	FOV	60 Deg's

Static Alignment	GPS Time	
	Start	End
Pre Mission	17:00	17:05
Post Mission	23:06	23:11

Flight Line	LiDAR File Name	Flight Direction	GPS Time		Ln Aborted Time	Date Stamp	ALS Time Stamp	Comments
			Start	End				
4063	15	9°	21:01	21:14			210137	
4064	16	189°	21:17	21:29			211745	
4065	17	9°	21:32	21:42			213244	
4066	18	189°	21:47	21:55			214702	
4067	19	9°	21:59	22:07			215915	
4068	20	189°	22:11	22:20			221112	
4069	21	9°	22:24	22:32			222408	
4070	22	189°	22:35	22:44			223553	
X-TIE	23	279°	22:48	22:52			224834	
PPP-8	-		22:52	22:57			-	Figure 8

Julian Day 327 Flt A

LIDAR Flight Log



Date	November 23, 2019	Aircraft	CFVZM
Project	3183_QSI_CascadeCounties	Pilot	J. Mathieson
Location	Yakima, WA	Operator	B. Eisenbart
Mission Objective			

System	1560i
Unit	38
IMU	Applanix AP50
GPS Rx	Trimble
Scanner 1 Drive	1
Scanner 2 Drive	2

Additional Notes

Aircraft Block Time			
Engine On	16:25	Ramp Out	Takeoff 16:42
Engine Off	20:59	Ramp In	Landing 20:49
Total	4.6 hrs	Total	4.1 hrs

Mission Plan			
AGL Height	2300 m	Pulse Rep Rate	700 kHz
Ground Speed	160 kts	Scan Rate	168 Hz
Laser Current	100 %	FOV	60 Deg's

Static Alignment	GPS Time	
	Start	End
Pre Mission	16:29	16:34
Post Mission	20:52	20:57

Flight Line	LiDAR File Name	Flight Direction	GPS Time		Ln Aborted Time	Date Stamp	ALS Time Stamp	Comments
			Start	End				
PPP-8	-		16:52	16:57			-	Figure 8
5058	3819327_01	82°	16:59		17:11		191123_165959	Clouds on east end of line, refly
4071	02	190°	17:16		17:25		171635	Clouds on south end of line, refly
2104	03	9°	17:37		17:40		173753	used scan settings for 2000m block
2104	04	9°	17:53	17:58			175315	changed settings for 2300m block
2103	05	189°	18:01	18:06			180144	
2102	06	9°	18:11	18:16			181107	
2101	07	189°	18:20	18:25			182024	
2100	08	9°	18:28	18:33			182835	
2099	09	189°	18:36	18:41			183631	
2098	10	9°	18:44	18:48			184421	
2097	11	189°	18:52	18:57			185227	
2096	12	9°	19:00	19:04			190012	

Julian Day 327 Flt A

LIDAR Flight Log



Date	November 23, 2019	Aircraft	CFVZM
Project	3183_QSI_CascadeCounty	Pilot	J. Mathieson
Location	Yakima, WA	Operator	B. Eisenbart
Mission Objective			

System	1560i
Unit	38
IMU	Applanix AP50
GPS Rx	Trimble
Scanner 1 Drive	1
Scanner 2 Drive	2

Additional Notes

Aircraft Block Time			
Engine On	16:25	Ramp Out	Takeoff 16:42
Engine Off	20:59	Ramp In	Landing 20:49
Total	4.6 hrs	Total	4.1 hrs

Mission Plan			
AGL Height	2300 m	Pulse Rep Rate	700 kHz
Ground Speed	160 kts	Scan Rate	168 Hz
Laser Current	100 %	FOV	60 Deg's

Static Alignment	GPS Time	
	Start	End
	Pre Mission	16:29
Post Mission	20:52	20:57

Flight Line	LiDAR File Name	Flight Direction	GPS Time		Ln Aborted Time	Date Stamp	ALS Time Stamp	Comments
			Start	End				
2095	13	189°	19:08	19:12			190808	
2094	14	9°	19:15	19:20			191531	
2093	15	189°	19:23	19:27			192300	
2092	16	9°	19:30	19:34			193017	
2091	17	189°	19:38	19:42			193808	
2090	18	9°	19:44	19:49			194458	
2089	19	189°	19:52	19:56			195219	
2088	20	9°	19:59	20:04			195957	
2087	21	189°	20:07	20:12			200750	
2086	22	9°	20:15	20:19			201531	
2085	23	189°	20:23	20:28			202321	Patches of snow to the west
X-TIE	24	99°	20:31	20:35			203136	
PPP-8	-		20:35	20:40			-	Figure 8

Julian Day 328 Flt A

LIDAR Flight Log



Date	November 24, 2019	Aircraft	CFVZM
Project	3183_QSI_CascadeCounties	Pilot	J. Mathieson
Location	Yakima, WA	Operator	B. Eisenbart
Mission Objective			

System	1560i
Unit	38
IMU	Applanix AP50
GPS Rx	Trimble
Scanner 1 Drive	1
Scanner 2 Drive	2

Additional Notes

Aircraft Block Time			
Engine On	16:10	Ramp Out	Takeoff 16:26
Engine Off	20:11	Ramp In	Landing 20:02
Total	4.0 hrs	Total	3.6 hrs

Mission Plan			
AGL Height	2000 m	Pulse Rep Rate	1000 kHz
Ground Speed	160 kts	Scan Rate	214 Hz
Laser Current	100 %	FOV	60 Deg's

Static Alignment	GPS Time	
	Start	End
Pre Mission	16:13	16:18
Post Mission	20:04	20:09

Flight Line	LiDAR File Name	Flight Direction	GPS Time		Ln Aborted Time	Date Stamp	ALS Time Stamp	Comments
			Start	End				
PPP-8	-		16:38	16:43			-	Figure 8
5058	3819328_01	83°	16:47	17:00			191124_164712	
5059	02	263°	17:05	17:21			170503	
5060	03	83°	17:24	17:38			172434	
5061	04	263°	17:42	17:58			174218	
5062	05	83°	18:01	18:14			180120	
X-TIE	06	353°	18:17	18:19			181754	
4117	07	190°	18:23	18:35			182320	
4116	08	10°	18:38	18:51			183856	
4115	09	190°	18:54	19:06			185445	
4114	10	10°	19:10	19:23			191006	
4113	11	190°	19:26	19:37			192616	Clouds nearby on the south end
X-TIE	12	100°	19:41	19:42			194111	
PPP-8	-		19:43	19:48			-	Figure 8

Julian Day 208 Flight A

LIDAR Flight Log



Date	July 26, 2020	Aircraft	C-GKX
Project	3183 QSI Cascade	Pilot	A. Murray
Location	Yakima WA	Operator	B. Eisenbart
Mission Objective			

System	Reigl Q 1560 II
Unit	51
IMU	Applanix AP60
GPS Rx	Trimble GNSS17
Scanner 1 Drive	
Scanner 2 Drive	

Additional Notes

Time to next maintenance: _____ ☉ 50 hr ○ 100 hr

Aircraft Block Time		
Engine On	14:55	Takeoff 15:13
Engine Off	21:13	Landing 21:03
Total	0.0 hrs	Total 6,101.1hrs

Mission Plan					
AGL Height	2300	m	Pulse Rate	700	khz
Target Speed	160	kts	Scan Rate	170	lps
Laser Current	100	%	FOV	60	degs

Static Alignment	GPS Time	
	Start	End
	Pre Mission	15:01
Post Mission	21:06	21:11

Flight Line	LiDAR File Name	Flight Direction	GPS Time		Line Aborted	Mission ID	Comments
			Start	End			
PPP-8		-	15:25	15:30		200726	figure 8
2084	512020801	009	15:34	15:39		153454	
2083	512020802	189	15:43	15:47		154309	
2082	512020803	009	15:53	16:01		155330	
2081	512020804	189	16:06	16:18		160629	
2080	512020805	009	16:20	16:33		162054	
2079	512020806	189	16:34	16:47		163443	
2078	512020807	009	16:49	17:01		164923	
2077	512020808	189	17:04	17:16		170422	
2076	512020809	009	17:19	17:31		171903	
2075	512020810	189	17:33	17:45		173311	
2074	512020811	009	17:47	18:00		174755	
2073	512020812	189	18:01	18:14		180149	
2072	512020813	009	18:16	18:28		181607	
2071	512020814	189	18:30	18:42		183032	

Julian Day 208 Flight A

LIDAR Flight Log



Date	July 26, 2020	Aircraft	C-GKX
Project	3183 QSI Cascade	Pilot	A. Murray
Location	Yakima WA	Operator	B. Eisenbart
Mission Objective			

System	Reigl Q 1560 II
Unit	51
IMU	Applanix AP60
GPS Rx	Trimble GNSS17
Scanner 1 Drive	
Scanner 2 Drive	

Additional Notes

Time to next maintenance: _____ ☉ 50 hr ○ 100 hr

Aircraft Block Time		
Engine On	14:55	Takeoff 15:13
Engine Off	21:13	Landing 21:03
Total	0.0 hrs	Total 6,101.1 hrs

Mission Plan					
AGL Height	2300	m	Pulse Rate	700	khz
Target Speed	160	kts	Scan Rate	170	lps
Laser Current	100	%	FOV	60	degs

Static Alignment	GPS Time	
	Start	End
Pre Mission	15:01	15:06
Post Mission	21:06	21:11

Flight Line	LiDAR File Name	Flight Direction	GPS Time		Line Aborted		Mission ID	Comments
			Start	End	Time	nmi to End		
2070	512020815	009	18:45	18:57			200726 Time Stamp	184533
2069	512020816	189	18:59	19:12				185943
2068	512020817	009	19:14	19:25				191421
2067	512020818	189	19:28	19:40				192812
2066	512020819	009	19:42	19:54				194224
2065	512020820	189	19:56	20:07				195611
2064	512020821	009	20:09	20:21				200938
2063	512020822	189	20:23	20:35				202309
X-TIE	512020823	099	20:41	20:45				204126
PPP-8		-	20:45	20:50				-
								figure 8

Julian Day 209 Flight A

LIDAR Flight Log



Date	July 27, 2020	Aircraft	C-GKX
Project	3183 QSI Cascade	Pilot	A. Murray
Location	Yakima WA	Operator	B. Eisenbart
Mission Objective			

System	Reigl Q 1560 II
Unit	51
IMU	Applanix AP50
GPS Rx	Trimble GNSS17
Scanner 1 Drive	
Scanner 2 Drive	

Additional Notes

Time to next maintenance: _____ ☉ 50 hr ○ 100 hr

Aircraft Block Time		
Engine On	14:42	Takeoff 14:59
Engine Off	20:19	Landing 20:09
Total	0.0 hrs	Total 101.1hrs

Mission Plan					
AGL Height	2300 m	Pulse Rate	700 khz		
Target Speed	160 kts	Scan Rate	170 lps		
Laser Current	100 %	FOV	60 degs		

Static Alignment	GPS Time	
	Start	End
	Pre Mission 14:47	14:52
Post Mission 20:12	20:17	

Flight Line	LiDAR File Name	Flight Direction	GPS Time		Line Aborted		Mission ID	Comments
			Start	End	Time	nmi to End		
PPP-8		-	15:14	15:19			200727	figure 8
2062	512020901	009	15:20	15:31			152010	
2061	512020902	189	15:34	15:46			153436	
2060	512020903	009	15:49	16:00			154905	
2059	512020904	189	16:02	16:14			160249	
2058	512020905	009	16:16	16:27			161647	
2057	512020906	189	16:30	16:42			163025	
2056	512020907	009	16:44	16:56			164441	
2055	512020908	189	16:58	17:09			165826	snow in peaks to the north
2044	512020909	009	17:13	17:25			171340	
2043	512020910	189	17:28	17:41			172828	
2042	512020911	009	17:42	17:54			174251	
2041	512020912	189	17:58	18:11			175801	
2040	512020913	009	18:13	18:25			181310	
2039	512020914	189	18:28	18:41			182819	

Julian Day 209	Flight A
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LIDAR Flight Log



Date	July 27, 2020	Aircraft	C-GKSX
Project	3183 QSI Cascade	Pilot	A. Murray
Location	Yakima WA	Operator	B. Eisenbart
Mission Objective			

System	Reigl Q 1560 II
Unit	51
IMU	Applanix AP50
GPS Rx	Trimble GNSS17
Scanner 1 Drive	
Scanner 2 Drive	

Additional Notes

Time to next maintenance: _____ ☉ 50 hr ○ 100 hr

Aircraft Block Time		
Engine On	14:42	Takeoff 14:59
Engine Off	20:19	Landing 20:09
Total	0.0 hrs	Total 1,101.1 hrs

Mission Plan			
AGL Height	2300 m	Pulse Rate	700 khz
Target Speed	160 kts	Scan Rate	170 lps
Laser Current	100 %	FOV	60 degs

Static Alignment	GPS Time	
	Start	End
Pre Mission	14:47	14:52
Post Mission	20:12	20:17

Flight Line	LiDAR File Name	Flight Direction	GPS Time		Line Aborted		Mission ID	Comments
			Start	End	Time	nmi to End		
2038	512020915	009	18:43	18:56			200727 Time Stamp 184346	
2037	512020916	189	18:59	19:12			185931	
2036	512020917	009	19:15	19:27			191519	moderate turbulence
2035	512020918	189	19:30	19:43			193038	moderate turbulence
X-TIE	512020919	99	19:49	19:53			194933	moderate turbulence
PPP-8		-	19:53	19:58			-	figure 8

Julian Day 211	Flight A
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LIDAR Flight Log



Date	July 29, 2020	Aircraft	C-GKX
Project	3183 QSI Cascade	Pilot	A. Murray
Location	Yakima WA	Operator	B. Eisenbart
Mission Objective			

System	Reigl VQ 1560 II
Unit	S2224051
IMU	Applanix AP60
GPS Rx	Trimble GNSS17
Scanner 1 Drive	
Scanner 2 Drive	

Additional Notes

high winds, turbulence in the mountains

Time to next maintenance: _____ ☉ 50 hr ○ 100 hr

Aircraft Block Time		
Engine On	14:51	Takeoff 15:10
Engine Off	18:59	Landing 18:50
Total	0.0 hrs	Total 101.1hrs

Mission Plan					
AGL Height	2300	m	Pulse Rate	700	khz
Target Speed	160	kts	Scan Rate	170	lps
Laser Current	100	%	FOV	60	degs

Static Alignment	GPS Time	
	Start	End
Pre Mission	14:55	15:00
Post Mission	18:52	18:57

Flight Line	LiDAR File Name	Flight Direction	GPS Time		Line Aborted		Mission ID	Comments
			Start	End	Time	nmi to End		
PPP-8		-	15:36	15:41			200729	figure 8
6001	512021101	330	15:41	15:43			154147	
6002	512021102	150	15:46	15:47			154600	
6003	512021103	330	15:50	15:52			155015	
6004	512021104	150	15:52	15:57			155221	
6005	512021105	330	16:01	16:03			160113	
6006	512021106	150	16:06	16:08			160641	
6007	512021107	330	16:11	16:14			161147	
6008	512021108	150	16:17	16:20			161737	
6009	512021109	330	16:23	16:25			162305	
6010	512021110	150	16:29	16:32			162903	
6011	512021111	330	16:35	16:37			163517	
6012	512021112	150	16:41	16:44			164129	
X-TIE	512021113	60	16:48	16:50			164843	Snow in the peaks to the east
6061	512021114	150	17:02	17:11			170243	snow patches on line

Julian Day 211 Flight A

LIDAR Flight Log

Date	July 29, 2020	Aircraft	C-GKXS
Project	3183 QSI Cascade	Pilot	A. Murray
Location	Yakima WA	Operator	B. Eisenbart
Mission Objective			

System	Reigl VQ 1560 II
Unit	S2224051
IMU	Applanix AP60
GPS Rx	Trimble GNSS17
Scanner 1 Drive	
Scanner 2 Drive	

Additional Notes	high winds, turbulence in the mountains
Time to next maintenance:	_____ ☉ 50 hr ○ 100 hr



Aircraft Block Time			
Engine On	14:51	Takeoff	15:10
Engine Off	18:59	Landing	18:50
Total	0.0 hrs	Total	101.1 hrs

Mission Plan					
AGL Height	2300	m	Pulse Rate	700	khz
Target Speed	160	kts	Scan Rate	170	lps
Laser Current	100	%	FOV	60	degs

Static Alignment		GPS Time	
Pre Mission	14:55	Start	End
Post Mission	18:52	18:52	18:57

Flight Line	LiDAR File Name	Flight Direction	GPS Time		Line Aborted		Mission ID	Comments
			Start	End	Time	nmi to End		
6060	512021115	330	17:13	17:20			200729	171316 moderate turbulence
6059	512021116	150	17:23	17:32			172356	172356 moderate turbulence
6058	512021117	330	17:35	17:42			173502	173502 moderate turbulence
X-TIE	512021118	60	17:47	17:48			174703	174703 Snow in the peaks to the west
6121	512021119	330	18:01	18:08			180140	180140 strong winds, moderate turbulence
PPP-8		-	18:11	18:16			-	- figure 8

Julian Day 212 Flight A

LIDAR Flight Log



Date	July 30, 2020	Aircraft	C-GKX
Project	3183 QSI Cascade	Pilot	A. Murray
Location	Yakima WA	Operator	B. Eisenbart
Mission Objective			

System	Reigl VQ 1560 II
Unit	S2224051
IMU	Applanix AP60
GPS Rx	Trimble GNSS17
Scanner 1 Drive	
Scanner 2 Drive	

Additional Notes

Time to next maintenance: _____ ☉ 50 hr ○ 100 hr

Aircraft Block Time		
Engine On	14:48	Takeoff 15:04
Engine Off	19:14	Landing 19:04
Total	4.4 hrs	Total 4.0 hrs

Mission Plan					
AGL Height	2300 m	Pulse Rate	700 khz		
Target Speed	160 kts	Scan Rate	170 lps		
Laser Current	100 %	FOV	60 degs		

Static Alignment	GPS Time	
	Start	End
	Pre Mission 14:52	14:57
Post Mission 19:07	19:12	

Flight Line	LiDAR File Name	Flight Direction	GPS Time		Line Aborted	Mission ID	Comments
			Start	End			
PPP-8		-	15:27	15:32		200730	figure 8
6121	512021201	330	15:32	15:39		153209	
6120	512021202	150	15:45	15:53		154524	
6119	512021203	330	15:56	16:03		155646	
6118	512021204	150	16:08	16:16		160839	
6117	512021205	330	16:19	16:27		161951	
6116	512021206	150	16:31	16:40		163154	
6115	512021207	330	16:44	16:52		164441	
6114	512021208	150	16:55	17:04		165547	
6113	512021209	330	17:07	17:15		170722	
6112	512021210	150	17:19	17:28		171924	
6111	512021211	330	17:32	17:40		173245	
6110	512021212	150	17:45	17:54		174508	
6109	512021213	330	17:58	18:06		175831	
X-TIE	512021214	240	18:12	18:14		181240	Snow in the peaks to the West

Julian Day 212 Flight A

LIDAR Flight Log



Date	July 30, 2020	Aircraft	C-GKXS
Project	3183 QSI Cascade	Pilot	A. Murray
Location	Yakima WA	Operator	B. Eisenbart
Mission Objective			

System	Reigl VQ 1560 II
Unit	S2224051
IMU	Applanix AP60
GPS Rx	Trimble GNSS17
Scanner 1 Drive	
Scanner 2 Drive	

Additional Notes

Time to next maintenance: _____ Ⓞ 50 hr ○ 100 hr

Aircraft Block Time		
Engine On	14:48	Takeoff 15:04
Engine Off	19:14	Landing 19:04
Total	4.4 hrs	Total 4.0 hrs

Mission Plan			
AGL Height	2300 m	Pulse Rate	700 khz
Target Speed	160 kts	Scan Rate	170 lps
Laser Current	100 %	FOV	60 degs

Static Alignment	GPS Time	
	Start	End
Pre Mission	14:52	14:57
Post Mission	19:07	19:12

Flight Line	LiDAR File Name	Flight Direction	GPS Time		Line Aborted		Mission ID	Comments
			Start	End	Time	nmi to End		
PPP-8		-	18:14	18:19			200730	figure 8

Julian Day 214 Flight A

LIDAR Flight Log



Date	Aug 1, 2020	Aircraft	C-GKX
Project	3183 QSI Cascade	Pilot	A. Murray
Location	Yakima WA	Operator	B. Eisenbart
Mission Objective			

System	Reigl VQ 1560 II
Unit	S2224051
IMU	Applanix AP60
GPS Rx	Trimble GNSS17
Scanner 1 Drive	
Scanner 2 Drive	

Additional Notes
 Strong turbulent winds developed in the mountains
 Time to next maintenance: _____ ☉ 50 hr ○ 100 hr

Aircraft Block Time		
Engine On	14:51	Takeoff 15:09
Engine Off	20:53	Landing 20:43
Total	6.0 hrs	Total 5.6 hrs

Mission Plan					
AGL Height	2300 m	Pulse Rate	700 khz		
Target Speed	160 kts	Scan Rate	170 lps		
Laser Current	100 %	FOV	60 degs		

Static Alignment	GPS Time	
	Start	End
	Pre Mission 14:55	15:00
Post Mission 20:46	20:51	

Flight Line	LiDAR File Name	Flight Direction	GPS Time		Line Aborted		Mission ID	Comments
			Start	End	Time	nmi to End		
PPP-8		-	15:26	15:30			200801 Time Stamp	Figure 8
2054	512021401	009	15:53	15:41			153118	
2053	512021402	189	15:44	15:55			154428	
2052	512021403	009	15:58	16:08			155848	
2051	512021404	189	16:11	16:22			161141	
2050	512021405	009	16:25	16:35			162538	
2049	512021406	189	16:39	16:50			163918	
2048	512021407	009	16:53	17:03			165329	
2047	512021408	189	17:06	17:16			170606	
2046	512021409	009	17:19	17:30			171950	
2045	512021410	189	17:34	17:47			173408	
X-TIE	512021411	009	17:56	17:58			175616	clouds nearby to the west
6108	512021412	330	18:18	18:26			181817	
6107	512021413	150	18:29	18:38			182912	
6106	512021414	330	18:42	18:50			184203	

Julian Day 214 Flight A

LIDAR Flight Log



Date	Aug 1, 2020	Aircraft	C-GKX
Project	3183 QSI Cascade	Pilot	A. Murray
Location	Yakima WA	Operator	B. Eisenbart
Mission Objective			

System	Reigl VQ 1560 II
Unit	S2224051
IMU	Applanix AP60
GPS Rx	Trimble GNSS17
Scanner 1 Drive	
Scanner 2 Drive	

Additional Notes
 Strong turbulent winds developed in the mountains
 Time to next maintenance: _____ ☉ 50 hr ○ 100 hr

Aircraft Block Time			
Engine On	14:51	Takeoff	15:09
Engine Off	20:53	Landing	20:43
Total	6.0 hrs	Total	5.6 hrs

Mission Plan					
AGL Height	2300 m	Pulse Rate	700 khz		
Target Speed	160 kts	Scan Rate	170 lps		
Laser Current	100 %	FOV	60 degs		

Static Alignment		GPS Time	
Pre Mission	14:55	Start	End
Post Mission	20:46	14:55	15:00
		20:46	20:51

Flight Line	LiDAR File Name	Flight Direction	GPS Time		Line Aborted		Mission ID	Comments
			Start	End	Time	nmi to End		
6105	512021415	330	18:53	19:02			200801	
6104	512021416	150	19:06	19:14			185333	
6103	512021417	330	19:17	19:26			190610	
6102	512021418	150	19:03	19:38			191716	winds in the peaks increasing
X-TIE	512021419	330	19:42	19:43			190329	
6062	512021420	150	19:50	19:55	19:55		194214	turbulence, aborted line
Test Strip		-	20:00	20:00			200022	
PPP-8		-	20:04	20:07			-	figure 8

LIDAR Flight Log



Date	August 05, 2020	Aircraft	C-GKX
Project	3183 QSI Cascade	Pilot	A. Murray
Location	Yakima WA	Operator	B. Eisenbart
Mission Objective			

System	Reigl VQ 1560 II
Unit	S2224051
IMU	Applanix AP60
GPS Rx	Trimble GNSS17
Scanner 1 Drive	
Scanner 2 Drive	

Additional Notes
 Low clouds on the west end of the project
 Time to next maintenance: _____ ☉ 50 hr ○ 100 hr

Aircraft Block Time		
Engine On	14:47	Takeoff 15:05
Engine Off	19:24	Landing 19:12
Total	4.6 hrs	Total 4.1 hrs

Mission Plan					
AGL Height	2300	m	Pulse Rate	700	khz
Target Speed	160	kts	Scan Rate	170	lps
Laser Current	100	%	FOV	60	degs

Static Alignment		GPS Time	
Pre Mission	14:51	Start	End
Post Mission	19:17	14:56	19:22

Flight Line	LiDAR File Name	Flight Direction	GPS Time		Line Aborted		Mission ID	Comments
			Start	End	Time	nmi to End		
PPP-8		-	15:37	15:42			200805	figure 8
6101	512021801	330	15:45	15:53			154500	
6100	512021802	150	15:56	16:06			155641	
6099	512021803	330	16:09	16:18			160934	
6098	512021804	150	16:21	16:30			162113	
6097	512021805	330	16:35	16:43			163506	
6096	512021806	150	16:46	16:56			164648	
6095	512021807	330	16:59	17:08			165957	
6094	512021808	150	17:11	17:21			171127	turbulence in the peaks
6082	512021809	330	17:23	17:31			172333	
6083	512021810	150	17:35	17:45			173548	
6084	512021811	330	17:49	17:58			174953	
6081	512021812	150	18:01	18:10			180119	
6080	512021813	330	18:13	18:21			181323	
6079	512021814	150	18:24	18:33			182430	

Julian Day 218 Flight A

LIDAR Flight Log



Date	August 05, 2020	Aircraft	C-GKXS
Project	3183 QSI Cascade	Pilot	A. Murray
Location	Yakima WA	Operator	B. Eisenbart
Mission Objective			

System	Reigl VQ 1560 II
Unit	S2224051
IMU	Applanix AP60
GPS Rx	Trimble GNSS17
Scanner 1 Drive	
Scanner 2 Drive	

Additional Notes
Low clouds on the west end of the project

Time to next maintenance: _____ ☉ 50 hr ○ 100 hr

Aircraft Block Time	
Engine On	14:47
Takeoff	15:05
Engine Off	19:24
Landing	19:12
Total	4.1 hrs

Mission Plan			
AGL Height	2300 m	Pulse Rate	700 khz
Target Speed	160 kts	Scan Rate	170 lps
Laser Current	100 %	FOV	60 degs

Static Alignment	GPS Time	
	Start	End
Pre Mission	14:51	14:56
Post Mission	19:17	19:22

Flight Line	LiDAR File Name	Flight Direction	GPS Time		Line Aborted		Mission ID	Comments
			Start	End	Time	nmi to End		
X-TIE	512021815	240	18:37	18:40			200805	clouds forming over AOI
PPP-8		-	18:41	18:46			183744	figure 8

Julian Day 223 Flight A

LIDAR Flight Log



Date	August 10, 2020	Aircraft	C-GKX
Project	3183 QSI Cascade	Pilot	A. Murray
Location	Yakima WA	Operator	B. Eisenbart
Mission Objective			

System	Reigl VQ 1560 II
Unit	S2224051
IMU	Applanix AP60
GPS Rx	Trimble GNSS17
Scanner 1 Drive	
Scanner 2 Drive	

Additional Notes

Time to next maintenance: _____ ☉ 50 hr ○ 100 hr

Aircraft Block Time		
Engine On	14:47	Takeoff 15:02
Engine Off	20:30	Landing 20:18
Total	5.7 hrs	Total 5.3 hrs

Mission Plan					
AGL Height	2300	m	Pulse Rate	700	khz
Target Speed	160	kts	Scan Rate	170	lps
Laser Current	100	%	FOV	60	degs

Static Alignment	GPS Time	
	Start	End
	Pre Mission	14:51
Post Mission	20:23	20:28

Flight Line	LiDAR File Name	Flight Direction	GPS Time		Line Aborted		Mission ID	Comments
			Start	End	Time	nmi to End		
PPP-8		-	15:25	15:29			200810	figure 8
6057	512022301	330	15:32	15:40			153234	
6056	512022302	150	15:43	15:50			154304	
6055	512022303	330	15:53	16:01			155315	clouds popping up on line
X-TIE 6055-57	512022304	240	16:07	16:08			160741	
2008	512022305	189	16:14	16:25			161441	
2009	512022306	009	16:27	16:38			162759	
2010	512022307	189	16:41	16:52			164138	
2011	512022308	009	16:55	17:07			165559	
2012	512022309	189	17:09	17:20			170916	
2013	512022310	009	17:23	17:34			172342	
2014	512022311	189	17:37	17:49			173742	
2015	512022312	009	17:52	18:03			175221	
2016	512022313	189	18:07	18:19			180721	
2017	512022314	009	18:22	18:33			182211	

Julian Day 223 Flight A

LIDAR Flight Log



Date	August 10, 2020	Aircraft	C-GKX
Project	3183 QSI Cascade	Pilot	A. Murray
Location	Yakima WA	Operator	B. Eisenbart
Mission Objective			

System	Reigl VQ 1560 II
Unit	S2224051
IMU	Applanix AP60
GPS Rx	Trimble GNSS17
Scanner 1 Drive	
Scanner 2 Drive	

Additional Notes	
Time to next maintenance:	_____ ☉ 50 hr ○ 100 hr

Aircraft Block Time		
Engine On	14:47	Takeoff 15:02
Engine Off	20:30	Landing 20:18
Total	5.7 hrs	Total 5.3 hrs

Mission Plan				
AGL Height	2300 m	Pulse Rate	700 khz	
Target Speed	160 kts	Scan Rate	170 lps	
Laser Current	100 %	FOV	60 degs	

Static Alignment	GPS Time	
	Start	End
Pre Mission	14:51	14:56
Post Mission	20:23	20:28

Flight Line	LiDAR File Name	Flight Direction	GPS Time		Line Aborted		Mission ID	Comments	
			Start	End	Time	nmi to End			
2018	512022315	189	18:37	18:48			200810 Time Stamp	183701	moderate turbulence
2019	512022316	009	18:51	19:03				185129	moderate turbulence
2020	512022317	189	19:06	19:19				190627	moderate turbulence
2021	512022318	009	19:22	19:34				192220	heavy turbulence
2034	512022319	189	19:37	19:46				193702	heavy turbulence - line aborted
X-TIE 2008-21	5120223	279	19:51	19:54				195121	
PPP-8		-	19:54	19:58				-	figure 8

LIDAR Flight Log



Date	August 11, 2020	Aircraft	C-GKX
Project	3183 QSI Cascade	Pilot	A. Murray
Location	Yakima WA	Operator	B. Eisenbart
Mission Objective			

System	Reigl VQ 1560 II
Unit	S2224051
IMU	Applanix AP60
GPS Rx	Trimble GNSS17
Scanner 1 Drive	
Scanner 2 Drive	

Additional Notes	
Time to next maintenance:	_____ ☉ 50 hr ○ 100 hr

Aircraft Block Time		
Engine On	14:44	Takeoff 15:00
Engine Off	20:35	Landing 20:24
Total	5.9 hrs	Total 5.4 hrs

Mission Plan					
AGL Height	2300 m	Pulse Rate	700 khz		
Target Speed	160 kts	Scan Rate	170 lps		
Laser Current	100 %	FOV	60 degs		

Static Alignment		GPS Time	
Pre Mission	14:49	Start	End
Post Mission	20:27	14:54	20:32

Flight Line	LiDAR File Name	Flight Direction	GPS Time		Line Aborted		Mission ID	Comments
			Start	End	Time	nmi to End		
Test Strip		-	15:19	15:28			200811 Time Stamp	
PPP-8		-	15:31	15:35			-	figure 8
6054	512022401	330	15:37	15:43			153704	
6053	512022402	150	16:45	15:51			154552	
6052	512022403	330	15:54	16:00			155423	
6051	512022404	150	16:03	16:10			160352	
6050	512022405	330	16:13	16:19			161329	
6049	512022406	150	16:22	16:27			162209	
6048	512022407	330	16:30	16:36			163029	
6047	512022408	150	16:39	16:45			163935	
6046	512022409	330	16:47	16:53			164734	
6045	512022410	150	16:56	17:01			165614	
6044	512022411	330	17:05	17:11			170535	
6043	512022412	150	17:14	17:19			171431	
6042	512022413	330	17:23	17:28			172303	

Julian Day 224 Flight A

LIDAR Flight Log



Date	August 11, 2020	Aircraft	C-GKX
Project	3183 QSI Cascade	Pilot	A. Murray
Location	Yakima WA	Operator	B. Eisenbart
Mission Objective			

System	Reigl VQ 1560 II
Unit	S2224051
IMU	Applanix AP60
GPS Rx	Trimble GNSS17
Scanner 1 Drive	
Scanner 2 Drive	

Additional Notes	
Time to next maintenance:	_____ ☉ 50 hr ○ 100 hr

Aircraft Block Time		
Engine On	14:44	Takeoff 15:00
Engine Off	20:35	Landing 20:24
Total	5.9 hrs	Total 5.4 hrs

Mission Plan					
AGL Height	2300 m	Pulse Rate	700 khz		
Target Speed	160 kts	Scan Rate	170 lps		
Laser Current	100 %	FOV	60 degs		

Static Alignment		GPS Time	
Pre Mission	14:49	Start	End
Post Mission	20:27	14:54	20:32

Flight Line	LiDAR File Name	Flight Direction	GPS Time		Line Aborted		Mission ID	Comments
			Start	End	Time	nmi to End		
6041	512022414	150	17:31	17:36			200811 Time Stamp	173132
6040	512022415	330	17:40	17:45				174014
6039	512022416	150	17:48	17:54				174832
6038	512022417	330	17:57	18:02				175726
6037	512022418	150	18:05	18:10				180534
6036	512022419	330	18:13	18:18				181326
6035	512022420	150	18:20	18:25				182053
6034	512022421	330	18:28	18:33				182840
6033	512022422	150	18:36	18:40				183610
6032	512022423	330	18:43	18:48				184343
6031	512022424	150	18:50	18:54				185040
6030	512022425	330	18:57	19:01				185751
6029	512022426	150	19:05	19:09				190508
6028	512022427	330	19:11	19:15				191144
6027	512022428	150	19:19	19:23				191904



Date	August 11, 2020	Aircraft	C-GKSX
Project	3183 QSI Cascade	Pilot	A. Murray
Location	Yakima WA	Operator	B. Eisenbart
Mission Objective			

System	Reigl VQ 1560 II
Unit	S2224051
IMU	Applanix AP60
GPS Rx	Trimble GNSS17
Scanner 1 Drive	
Scanner 2 Drive	

Additional Notes

Time to next maintenance: _____ ☉ 50 hr ○ 100 hr

Aircraft Block Time	
Engine On 14:44	Takeoff 15:00
Engine Off 20:35	Landing 20:24
Total 5.9 hrs	Total 5.4 hrs

Mission Plan				
AGL Height	2300 m	Pulse Rate	700 khz	
Target Speed	160 kts	Scan Rate	170 ips	
Laser Current	100 %	FOV	60	degs

Static Alignment	GPS Time	
	Start	End
	Pre Mission 14:49	14:54
Post Mission 20:27	20:32	

Flight Line	LiDAR File Name	Flight Direction	GPS Time		Line Aborted		Mission ID	Comments
			Start	End	Time	nmi to End		
6026	512022429	330	19:25	19:30			192552	
6025	512022430	150	19:32	19:36			193233	
6024	512022431	330	19:39	19:43			193949	clouds to the west
X-TIE	512022432	060	19:47	19:51			194710	
2034		189	19:57	20:01	20:01		195744	clouds on line - refly
PPP-8		-	20:01	20:06			-	figure 8

