Idaho Statewide Lidar Plan
Draft 1.1

Authors

The Elevation Technical Working Group (Elevation TWG) of the Idaho Geospatial Office, State of Idaho and the Idaho Lidar Consortium developed the State of Idaho Lidar Plan in August 2017. This plan was reviewed by members of the Elevation TWG in XX, emailed to the Geotech listserv in XX, and approved by Y in XX.

Elevation TWG

Table of Contents

Introduction

Light detection and ranging (Lidar), is a laser-based technology that provides 3-dimensional (3-D) data to develop bare earth, canopy, and other models of the earth's surface necessary for mapping applications. Lidar's capabilities to derive fine-scale, 3-D data across relatively large swaths of the landscape make it unique from other Earth surface mapping technologies such as optical imagery (e.g. airborne-based National Agriculture Imagery Program (NAIP) imagery or satellite based Landsat). Lidar is most commonly collected via airborne platforms when large swaths of data are needed. Nationally, lidar has been collected by local, state and federal agencies, tribal governments, private sectors, universities, and non-governmental organizations (NGOs), often in overlapping areas and/or in "postage-stamp" acquisitions. Until the United States Geological Survey (USGS) developed the 3D Elevation Program (3DEP) program in 2012, there was no nationally-coordinated program (USGS, 2017). Whereas the 3DEP program provides seed funding for data collections, additional funds and partnerships are needed to acquire lidar data wall-to-wall (nationally) and on a repeat basis.

High resolution elevation data, collected in the form of lidar, provides tremendous opportunity for the State of Idaho by providing baseline information for emergency management, transportation infrastructure, natural resources, education, environmental health, and a host of other disciplines and strategic areas for the State of Idaho. More discussion regarding these opportunities are presented below. Numerous states have already acquired statewide lidar data (e.g., North Carolina, Virginia, Pennsylvania, Maryland, Iowa, Louisiana, Minnesota, Massachusetts, Indiana, Delaware, Connecticut, and Ohio) or have plans in place to acquiring statewide lidar (e.g., Oregon, Vermont, New Mexico, Tennessee, Kentucky, Utah, Kansas, and Florida).

Objective

The objective of this plan is to establish an approach to acquire statewide lidar data for Idaho. The document makes recommendations of the steps necessary to acquire, store, and serve these data, along with the specifications associated with these data acquisitions and its derived products. The intent is to be inclusive and find opportunities for data collectors, users, and practitioners of lidar to work together for the benefit of the State of Idaho. This document is intended to provide a series of best practices relative to lidar data and will be updated as appropriate.

Uses and Opportunities for Lidar in Idaho

Business Uses for Lidar Data

The USGS 3DEP identified 27 business uses for high precision elevation data (Sugarbaker, 2014; Maune, 2017) (Table 1). The 3DEP's business terminology has been applied to all states and is comprehensive, although not all uses are applicable to all states. Annual benefits for each business use were determined by 3DEP and have been used to assist in ranking or prioritizing data collections (Carswell, 2013, updated in Maune, 2017). Idaho's top 10 business uses are shown in Table 2 (Dewberry, 2011). While agriculture and precision farming are ranked as the top business use in Table 2, this may be explained by the fact that this use doesn't employ public domain lidar. The largest user of publicly available lidar in the state is for flood risk management. This observation is based on the majority of lidar datasets collected and shared on the Idaho Lidar Consortium funded by FEMA.

Table 1. Business use and estimated annual benefits (table from Maune, 2017).

BU#	Business Use (BU) Name	Enhanced Elevation Data Annual Benefits: Conservative Benefits	Enhanced Elevation Data Annual Benefits: Potential Benefits
14	Flood Risk Management	$440.853M	$787.886M
21	Infrastructure and Construction Management	$246.311M	$974.643M
1	Natural Resources Conservation	$169.037M	$337.164M
8	Agriculture and Precision Farming	$122.330M	$2,011.330M
2	Water Supply and Quality	$85.659M	$156.583M
16	Wildfire Management, Planning and Response	$84.250M	$166.950M
9	Geologic Resource Assessment and Hazard Mitigation	$54.235M	$1,069.235M
5	Forest Resources Management	$43.949M	$61.655M
3	River and Stream Resource Management	$39.564M	$86.632M
20	Aviation Navigation and Safety	$35.000M	$56.000M
4	Coastal Zone Management	$23.785M	$41.740M
17	Homeland Security, Law Enforcement, Disaster Response	$10.444M	$126.544M
11	Renewable Energy Resources	$10.050M	$100.050M
12	Oil and Gas Resources	$10.000M	$100.000M
22	Urban and Regional Planning	$7.415M	$68.744M
15	Sea Level Rise and Subsidence	$5.800M	$21.660M
10	Resource Mining	$1.686M	$4.864M
7	Wildlife and Habitat Management	$1.510M	$4.020M
13	Cultural Resources Preservation and Management	$0.800M	$7.000M
25	Education K-12 and Beyond	$0.514M	$2.514M
18	Land Navigation and Safety	$0.316M	$7,125,000M[1]
27	Telecommunications	$0.185M	$1.850M
26	Recreation	$0.100M	$0.100M
23	Health and Human Services	$0.000M	$1.000M
19	Marine Navigation and Safety	$0.000M	$0.000M
24	Real Estate, Banking, Mortgage, Insurance	$0.000M	$0.000M
6	Rangeland Management	$0.000M	$0.000M
	Total Estimated Annual Dollar Benefits	**$1,393.793M**	**$13,313.164M**

[1] The major potential benefits for BU#18 would not be realized until car/truck/bus manufacturers start deploying vehicles that save fuel by automatically downshifting or upshifting, in advance of changing curves and grades ahead, based on LIDAR or other 3-D mapping technology that will provide the 3-D roadway geometry. Research programs and car manufacturers have estimated that road elevation/slope data, combined with transmission-control technology and in-vehicle location and navigation products, will enable fuel consumption to decrease by 4-12%, saving many billions of dollars annually for American drivers. State and county DOTs will also greatly benefit.

Table 2. Top 10 business use benefits of the 3DEP program for the State of Idaho (based on Dewberry, 2011 and USGS Fact Sheet 2013-3053, https://pubs.usgs.gov/fs/2013/3053/pdf/fs2013-3053.pdf).

Rank	Business use	Annual benefits (millions)
1	Agriculture and precision farming	$1.71
2	Natural resources conservation	1.63
3	Infrastructure and construction management	1.03
4	Geologic resource assessment and hazard mitigation	0.62
5	Flood risk management	0.46
6	Forest resources management	0.41
7	Aviation navigation and safety	0.08
8	Renewable energy resources	0.06
9	River and stream resource management	0.05
10	Water supply and quality	0.04
Other		0.03
Total		6.12

There are a number of example sectors involved in lidar business uses in the State of Idaho, including government agencies, industry, and research (these also include the top 10 business uses for Idaho identified by 3DEP) (Table 3).

Table 3. Sectors involved in lidar business uses in the State of Idaho.

3DEP Business Use	Specific Application	Sector	Comment
Agriculture and precision farming	• Fertilizer application • Erosion • Topography	Agribusiness	No current datasets for this use presently in public domain, however datasets are in private domain
Natural resources conservation	• Riparian habitat/wetlands recovery and watershed restoration • Weeds/invasive species assessment • Erosion studies • Wildlife habitat management and protection • Land cover mapping • Archeological site identification	State agencies including Idaho Fish and Game, Idaho Department of Lands (IDL); Federal agencies including US Forest Service (USFS), Bureau of Land Management (BLM), University	
Infrastructure and construction management	• Transportation corridor planning, for highways, rail lines and connective services • Location of utilities, power lines, telephone poles, cell phone towers	Agencies including Idaho Transportation Department (ITD), counties, cities; Public utilities	Mobile ground-based lidar is also used by ITD

Geologic resource assessment and hazard mitigation	• Geologic mapping • Active faults • Landslide inventory and susceptibility mapping • Abandoned mines, prospects, tailings • Soil Surveys	Idaho Geologic Survey (IGS), IDL, USGS, Idaho Bureau of Homeland Security (IBHS), Idaho Department of Water Resources (IDWR), Idaho Department of Environmental Quality (IDEQ), ITD, mining, oil & gas industry, counties, cities, timber companies, USFS, BLM, USDA NRCS	
Flood risk management	• Floodplain mapping • Debris flow mapping • Urban storm water flow analysis • Dams, levee and canal failures	FEMA, IDWR, IBHS, counties, cities, US Bureau of Reclamation (USBR), US Army Corps of Engineers (USACE)	Most public domain lidar in Idaho from FEMA floodplain mapping
Forest resources management	• Wildfire • Forest inventory, canopy analysis, and operations planning and management	USFS, BLM, IDL, ITD, IBHS, NRCS, USACE, counties, cities, university, timber companies, tribal governments	
Renewable energy resources	• Wind turbine siting	Utilities	Use cases unknown
River and stream resource management	• Riparian habitat recovery and watershed restoration	USFS, BLM, IDL, timber companies, tribal governments, NGOs	
Water supply and quality	• Surface water storage	IDWR, USBR, USACE	

Status of Lidar in Idaho

As of 2018, less than 16.5% of the State of Idaho has freely-available, public lidar data that was collected before 2008 (see Figure 1). An additional 1% of the state has data collected prior to 2008. Lidar technology has advanced tremendously since these data were collected. Where lidar data are not available in Idaho, we rely upon the USGS National Elevation Dataset (NED) with 10 m spatial resolution.

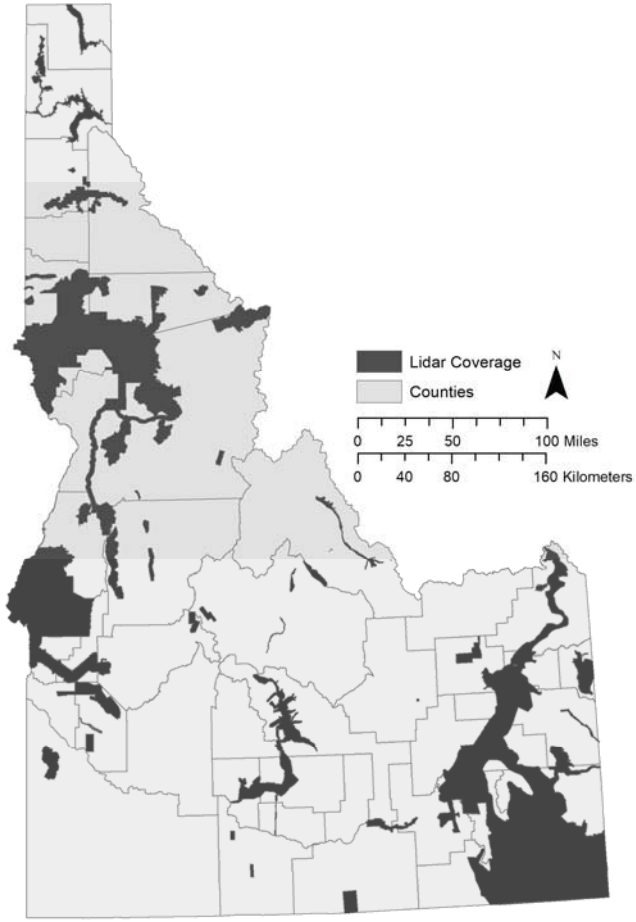

Figure 1. Existing lidar coverage in Idaho, as of 2018. All datasets here are shown to be collected between 2008-2018. Datasets prior to 2008 are not considered given the poor sampling.

Cost & Funding Approach

The cost to acquire statewide lidar data for Idaho is approximately $40M (Maune, 2017). This estimate is based on collecting Quality Level 1 (QL1) USGS Lidar Base Specification Version 1.3 (USGS, 2018) statewide in one acquisition, and to store and distribute lidar and the derivative products most useful to the community. While it is most cost-effective (based on acquisition costs and cost-benefit, Maune, 2017) to acquire statewide lidar in one acquisition, it is unlikely that this amount of funding is available for lidar during one fiscal year. Therefore, we propose an 8-year phased approach to the statewide data acquisition. Of course, a phased approach will require repeating the process once complete. Based on previous acquisitions, we estimate $0.50-1.00/acre for QL1 lidar acquisition at the time of writing this document (Table 4). To accomplish the phased approach, we will leverage partnerships available through the USGS 3DEP, Federal Emergency Management Agency, and numerous other participating agencies as opportunities arise.

Table 4. Proposed phased approach. Cost is a rough estimate based on $0.50/acre.

Description	Area (km^2)	Cost (km^2)*	Percent Total (of 216,630 km^2)
Current lidar coverage	35,815	--------------	16.5%
Suggested coverage 2019-2022	75,600	$ 9,000,000*	52%
Suggested coverage 2023-2026	105,200	$ 12, 000,000*	100%
Data and management cost (2017 projected cost)	---------------	Approximately 5%	-------------------------
Total	216, 630		-------------------------

Priority Areas

A phased statewide lidar acquisition plan requires prioritization of areas to be collected. There are many approaches to determine priority areas, including risk to population and natural resources, and availability of funding. Acquiring large blocks of areas is the most economical and efficient for statewide acquisition and thus, we propose either HUC-8 watersheds and/or county boundaries for planning.

The ILC developed a survey to evaluate priority ranking of HUC-8 watershed areas across the State of Idaho. This survey was distributed to state and federal agencies as well as organizations that expressed interest in lidar in 2017. We had 50 respondents to the survey. The response data has been formatted into Figure 2. We acknowledge that this is just one method to determine priority areas of lidar coverage for the state.

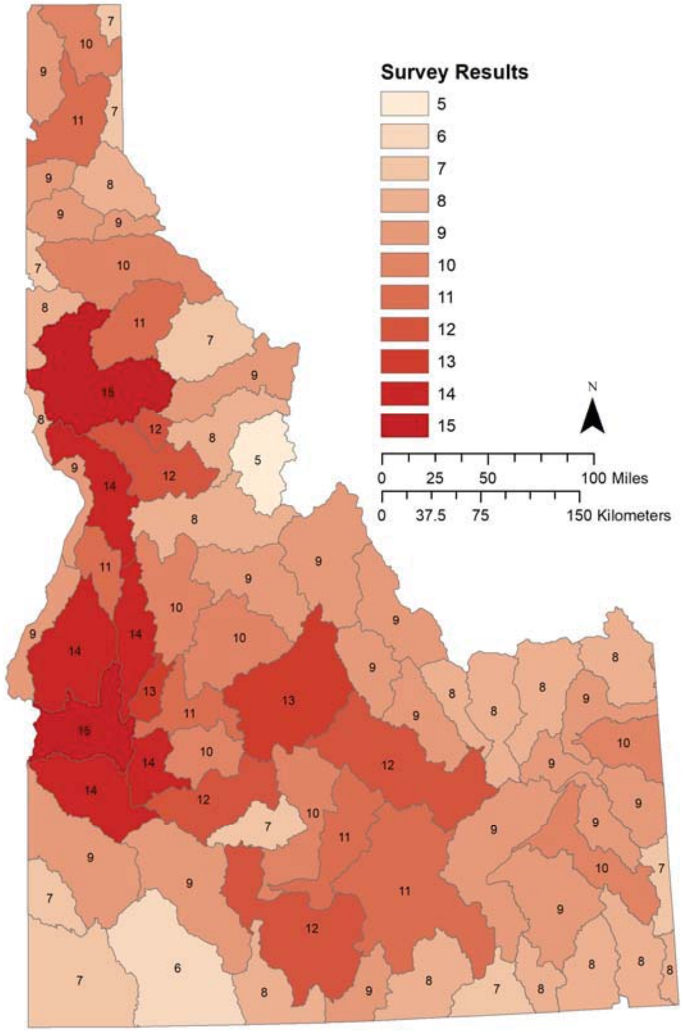

Figure 2. Priority watersheds based on survey. Survey results indicate number of user requests.

Coordination

The Idaho Lidar Consortium (ILC) and the Elevation Technical Working Group (ETWG) are part of the State of Idaho's Geospatial framework. The ILC is composed of a volunteer group that coordinates lidar acquisitions in Idaho. The most frequently used webpage of the ILC website (http://idaholidar.org) is the map of where lidar data have been collected as well as where one or more party has expressed an interest in collecting data. The latter information allows the ILC to leverage group buy-ups of future lidar acquisitions thus driving costs per area down considerably. The reader is encouraged to visit the ILC website and become familiar with planned acquisition areas. The ILC voluntarily accepts data for areas where lidar data has been collected and enables data discovery and sharing. While there is no formal membership of ILC, those participating include people who provide lidar data collection information (location and/or data), participate in coordination of lidar acquisitions that will become publically available via ILC, and those who seek information on how to collect or process lidar data.

To share data collection information, people are encouraged to email bcal@boisestate.edu to coordinate the necessary information and distribution. Coordination of lidar data collections can also start with this email, and are usually facilitated ad-hoc with announcements on the State of Idaho's Geotech list-serv (http://admws.idaho.gov/mailman/listinfo/geotech), coordination with the IGC meetings, and email notifications. The ETWG meets on an as needed basis and its membership is comprised of geospatial professionals who volunteer their time and represent state, federal, tribal, private, and university interests. The intent of this state TWG is to coordinate elevation data products in the state. There is no formal membership with ETWG and communication takes place primarily using the Geotech list-serv. Any and all interested parties are welcome to become involved in the ETWG. The best mechanism to become involved in ETWG is to subscribe to the Geotech list-serv and attend the meetings.

State of Idaho Specifications for Airborne Lidar Data and Delivery

In order to ensure the best data quality for a range of business uses in the State of Idaho, the ETWG and ILC recommend all lidar data be collected as USGS Quality Level 1 (QL1). Information on USGS QL1 and other information on lidar can be found in the USGS Lidar Base Specification Version 1.3 (USGS, 2018).

We have also developed Appendix A as a guide on specifications and considerations when acquiring lidar data. These specifications exceed what is recommended by QL1 and are suggested as options to consider. These suggested specifications are for acquiring lidar data, the accompanying LAS files, LAS file header information, metadata, and control point survey information. Similar to the information described by the USGS' QL1, these recommended specifications are intended to provide the widest community use of lidar data, while also being cost effective. However, specific applications may require different specifications. In general we recommend using these specifications along with the USGS QL1 specifications in parallel. Note, one major difference between our recommendations and the USGS specifications is the point density. This acquisition plan recommends a minimum 12 pts/m^2 whereas QL 1 is 8 pts/m^2. This recommendation of 12 pts/m^2 is based on: 1) previous experience where agencies have acquired coarser data only to find their features of interests (e.g., streams and topography) are not sufficiently captured; 2) the need for a statewide coverage standard to ensure consistency; and 3) to improve the cost:benefit ratio by increasing the number of potential users of the data collected. That said, if agencies are unable to acquire at 12 pts/m^2, we recommend using no lower than QL 1 as described by the USGS. There are a number of distinguishing characteristics between the Quality Levels described by the USGS (2018); however, one of the major considerations with QL1 is the >8 pts/m^2 requirement and its accompanying relative and absolute vertical accuracy requirements. QL2 data will not provide long-term data usability nor enable multi-agency use, thus negating any cost benefit with the even coarser data collection.

Data Storage and Distribution

Publicly available Idaho lidar data are currently distributed through the Idaho State University's GIS Training and Research Center (GIS TReC) via Globus Online and links from the ILC. University of Idaho's INSIDE Idaho Geospatial Data Clearinghouse also distributes lidar data. As lidar acquisition increases, infrastructure to support storage and data distribution will need to be assessed and current infrastructure will potentially need to be supplemented. Financial considerations on how to support the current infrastructure and implement new infrastructure will need to be resolved. Lidar and its derivative products represent Terabytes (TB) of data and the current infrastructure will need to be supplemented as data acquisitions increase. The final derivative products will continue to be made available for download through the ISU GIS TReC using the Globus online data transfer utility.

Training, Support, and Outreach

Training, support, and outreach are necessary components to successfully implement and use statewide lidar. While there are opportunities for training by private industry and universities, additional training and support opportunities are needed based on the 2017 ILC survey results. Specifically, statewide training needs include: downloading lidar data, introduction to lidar, lidar data processing, contracting lidar acquisitions, best practices, and using lidar data products. Idaho State University, University of Idaho, and Boise State University provide courses in remote sensing with lidar as a major focus. However, these semester-long courses are not ideal for professionals. Periodic lidar training has occurred by all the universities as well as by private industry, but are not offered regularly. Coordination needs to occur between ILC, private industry, and the universities to host regular short-courses and/or webinars throughout the state.

Support for outreach via the Idaho Lidar Consortium is also needed. Outreach opportunities to new business partners, including city and county administration is needed. Currently, the ILC is run on a volunteer basis and future expansion will need to be supported.

Recommendations/Conclusions

We propose achieving statewide lidar coverage within 8 years (2026) by prioritizing areas of need (Figure 2) as often as possible and leveraging partnerships. We also recommend consideration of training and outreach that is needed for statewide lidar. This document should be updated as new technologies and drivers become available. The lidar specifications and derivative products should also be updated as technologies are updated. We also recommend maintaining an accurate cost estimate recognizing new lidar data acquisitions in the state as they occur.

Acknowledgements

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Boise State University
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Idaho Department of Lands
Idaho Department of Water Resources
Idaho Geospatial Office
Idaho Geologic Survey
Idaho Natural Resources Conservation Service, USDA
Idaho State University
Idaho Transportation Department
USFS

References

Sugarbaker, L.J., Constance, E.W., Heidemann, H.K., Jason, A.L., Lukas, Vicki, Saghy, D.L., and Stoker, J.M., 2014, The 3D Elevation Program initiative—A call for action: U.S. Geological Survey Circular 1399, 35 p., *https://dx.doi.org/10.3133/cir1399*. http://pubs.usgs.gov/circ/1399/

Carswell, W.J., Jr., 2013. The 3D Elevation Program—Summary for Idaho: U.S. Geological Survey Fact Sheet 2013–3053, 2 p., *https://dx.doi.org/10.3133/fs20143014*. https://pubs.usgs.gov/fs/2013/3053/

Dewberry, 2011, Final report of the National Enhanced Elevation Assessment (revised 2012): Fairfax,
Va., Dewberry, 84 p. plus appendixes. http://www.dewberry.com/Consultants/GeospatialMapping/FinalReport-Nation alEnhancedElevationAssessment.

Maune, 2017. National Enhanced Elevation Assessment (NEEA)—Part 3: The Cost-Benefit Analysis Process. Lidar Magazine, Vol. 7 No. 1. URL accessed July 2017: http://www.lidarmag.com/PDF/LIDARMagazine_Maune-NEEA_Vol7No2.pdf

USGS, 2017. 3D Elevation Program (3DEP). URL accessed July 2017: https://nationalmap.gov/3DEP/index.html

USGS, 2014. National Geospatial Program. Lidar Base Specification. Chapter 4 of Section B, U.S. Geological Survey Standards Book 11, Collection and Delineation of Spatial Data. URL accessed July 2017: https://pubs.usgs.gov/tm/11b4/pdf/tm11-B4.pdf.

Additional resources

Oregon Lidar Consortium and Lidar Specification -UPDATED
http://www.oregongeology.org/lidar/DAS-Quantum_7525Amendment7.pdf

Minimum Lidar Data Density Considerations for the Pacific Northwest (PDF) - UPDATED
http://www.oregongeology.org/lidar/minimum-lidar-data-density.pdf

USGS Lidar Base Specification Version 1.3
https://pubs.usgs.gov/tm/11b4/pdf/tm11-B4.pdf

Lidar Division
https://www.asprs.org/Divisions/Lidar-Division.html

ASPRS Guidelines LAS
http://www.asprs.org/Committee-General/LASer-LAS-File-Format-Exchange-Activities.html

Vertical Accuracy Reporting of Lidar Data V1.0, (ASPRS, 2004)
http://www.asprs.org/a/society/committees/lidar/Downloads/Vertical_Accuracy_Reporting_for_Lidar_Data.pdf

Horizontal Accuracy Reporting of Lidar Data
http://www.asprs.org/a/society/committees/standards/Horizontal_Accuracy_Reporting_for_Lidar_Data.pdf

Positional Accuracy Standards for Geospatial Data
https://www.asprs.org/pad-division/asprs-positional-accuracy-standards-for-digital-geospatial-data.html

Standards for Lidar and Other High Quality Digital Topography FEMA, 2010.

USGS Lidar Science Strategy: Mapping the Technology to the Science
https://pubs.usgs.gov/of/2015/1209/ofr20151209.pdf

Appendix A.

Lidar Specifications

The lidar data should meet the following specifications – suggestions for best data:

- Pulse (point) density of >12 pulses/m$^{2;}$ the pulse density should be determined based on the needs of the project; this minimum is suggested in order to make these data useful for a wide range of applications. Lower pulse density is unlikely to result in useful data for most quantitative analyses.
- Capability of 4 returns per pulse (minimum)
- Flight lines with 50% side-lap (or at least 150 ft. side-lap) (two sensors per plane)
- Scan angle of <30^{o} (+/- 15^{o})
- Vertical RMSE commensurate to objectives; over flat/open surfaces <5 cm;
- Horizontal RMSE commensurate to objectives; over flat/open surfaces <30 cm (based on flight altitude). Horizontal errors should demonstrate randomness relative to direction (N-S versus E-W), and horizontal RMSE should be evaluated with control points.
- Spatially distributed real-time kinematic control points collected across each landcover type (e.g. dense overstory with grass/shrub understory, riparian, grass/shrub, urban, agriculture, and bedrock versus regolith) and slope category (0-5, 5-10, 15+^{o}) in the study area;
- Control points should be spatially distributed across each flightline and include a minimum of 3 permanent recoverable control points (monuments or benchmarks) tied to the most current national geodetic datum
- Calibrated intensity data (e.g. with Automatic Gain Control (AGC) correction, if needed, given the given the sensor type, but without normalization)

Data Delivery

- All-return unclassified point cloud delivered in LAS format (v 1.4 or other agreed upon format)
- All-return classified point cloud delivered in LAS format (v 1.4 or other agreed upon format); classification in ASPRS LAS standards
- Complete metadata in XML following FGDC standards detailing data quality information (accuracy assessment) and processing steps including software used to achieve the delivered point cloud data
- Flight path trajectory information (SBETs) (at least X, Y, Z, time, roll, pitch, heading velocity)
- Project and data collection reports including equipment used, equipment accuracy (assumed and manufacturer’s stated accuracy), details of mission efforts including a QA/QC assessment (summary statistics broken down by land cover and slope type, histograms, etc), survey extent, positional accuracy and accuracy assessment, and classification of points.
- Survey report with locations and accuracy of all control and reference points including permanent monitoring locations, equipment used, and equipment accuracy (assumed and manufacturer’s stated accuracy)

The following information need to be contained in the LAS file for each return (note: this follows the Point Data Record (Format 3) of the ASPRS LAS specification)

- X, Y, and Z coordinates
- Intensity
- Return Number
- Number of Returns for given pulse
- Scan Direction Flag

- Edge of Flight Line
- Classification
- Scan Angle Rank
- User Data
- Point source ID
- GPS Time (GPS Week Time and Absolute GPS Time, POSIX)
- Red, Green Blue (if digital imagery are collected)

The LAS file header information should include the following at a minimum (note this follows the Public Header Block of the ASPRS LAS specifications).

- Global Encoding Information
- System Identifier
- Generating Software
- Georeferencing information (in GeoTiff Specification)

The vendor should also provide the following:

Derived Products

- All derived products should be in the requested file formats (e.g. TIFF or GeoTIFF) with coordinate system embedded and with complete metadata including software and processing steps used to create the derived products. Coordinate systems and projections: Idaho Transverse Mercator (IDTM), UTM Zone 11N and 12N, or other as long as the coordinates (x, y, z) are in meters; Horizontal: GCS NAD 1983(2011) Vertical: NAVD 1988; GEOID 12B or current
- Bare Earth Model
- Surface Model
- Hydro-enforced DEM with break lines
- Hydro-flattened DEM
- Contour lines (2 foot, 1 meter, or other as appropriate)
- Ground point density image
- Intensity return image

Other recommendations

- Clearly delineate the project goals with the vendor and ask to be involved in the flight planning process
- The best practice is to have an independent licensed surveyor provide the above ground survey (instead of the lidar vendor); the data requester should also perform an independent survey. While the independent survey may add to the cost, it ensures an unbiased data accuracy assessment.
- Consider timing of the acquisition (e.g. leaf on/off; high/low river flows; snow on/off)
- Optical data (e.g. digital imagery) should be co-acquired with lidar due to minimal additional cost and the opportunity to check lidar for accuracy, as well as a wide range of additional other uses of the aerial imagery.
- At minimum two flightlines should be perpendicular to all other flightlines, one at each end of the study area
- Consider the scan angle and flight line orientation in reference to the landforms in the study area
- Consider locations where higher and/or lower point densities may be needed in the study area
- Define the coordinate system to be used (including Geoid). See above.
- The vendor should coordinate with land-owners for site access.
- Consider LAZ format if needed to save space. Note that not all software can read LAZ format.