

VBMP LiDAR Products

VIRGINIA BASE MAPPING PROGRAM

LiDAR (light detection and ranging) is a technology that determines distance to an object or surface using laser pulses to measure elevation and provide the greatest possible detail. Today, with innovations such as multiple intensity returns and increased repetition rates, LiDAR technology can be used for creating three-dimensional topographical maps and highly accurate surveys of both surface terrain and manmade structures.

LiDAR is used in a variety of industries, including geography, forestry, oceanography, and emergency management. Deciding how to use LiDAR for an application can be difficult. To simplify this process, Sanborn offers three types of LiDAR products that can assist any client in determining which is most appropriate for a particular application:

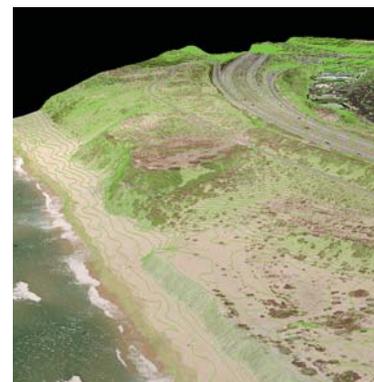
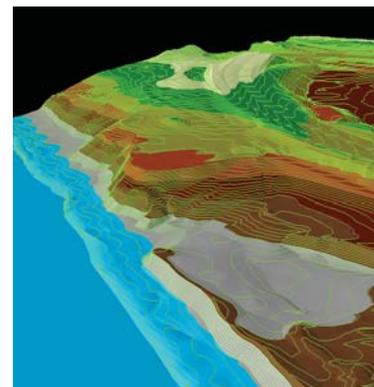
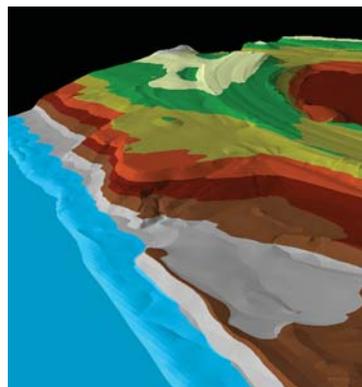
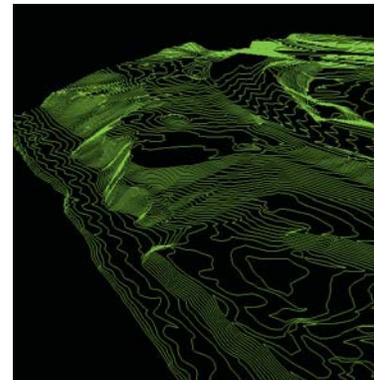
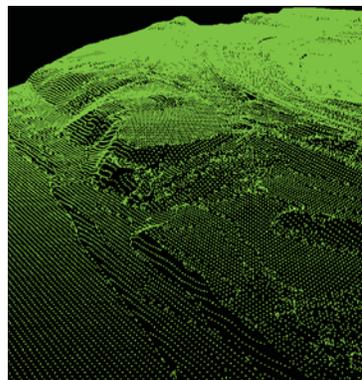
- › **Standard**
- › **FEMA Compliant**
Deliverable as:
 - › 1.0 meter average point spacing
 - › 1.4 meter average point spacing
- › **High Density**

LiDAR Applications

LiDAR advances and better understanding of the technology have greatly improved the usefulness of LiDAR as a valuable mapping tool. Applications include:

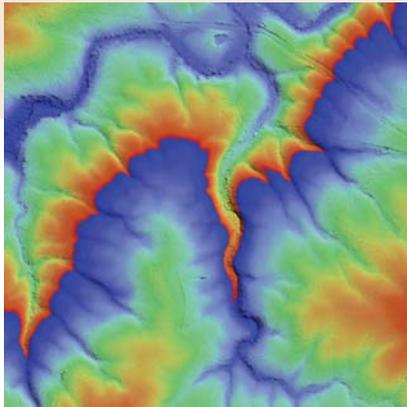
- › 3-D modeling
- › Flood mapping and planning
- › Disaster management
- › Coastal erosion
- › Aviation safety
- › Forestry
- › Nautical charting
- › Land use mapping and planning
- › Volumetric studies
- › Transmission

Sanborn LiDAR products are furnished as bare-earth DEMs (Digital Elevation Model) and can be optionally upgraded to a DTM (Digital Terrain Model) and/or contour product.



Above: Sanborn LiDAR data showing contours, TIN (Triangular Irregular Network) and 3D drape with orthophoto imagery.

VBMP LiDAR Products, continued



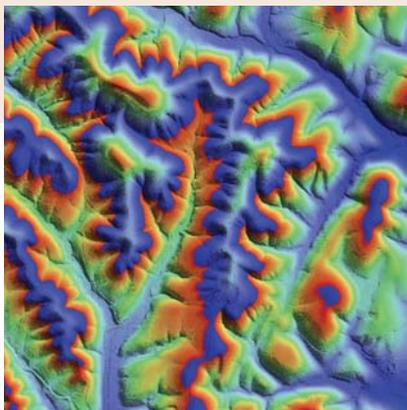
Standard LiDAR

Standard LiDAR products are used as a cost effective way to collect large-area projects in a time constrained environment. As a general use, Sanborn's Standard LiDAR products meet most needs for LiDAR-based elevation models.

Typical uses for the dataset include:

- › Generation of bare-earth elevation models in sparse to moderate vegetative terrain
- › Large area elevation models where vertical and horizontal positional accuracy are paramount
- › Watersheds and other hydro studies
- › Tree canopy size analysis for fuels and fire models
- › Building and manmade structure detection and 3-D modeling

The Sanborn Standard LiDAR product is furnished as a bare earth digital elevation model (DEM) and can be optionally upgraded to a digital terrain model (DTM) and/or contour product.



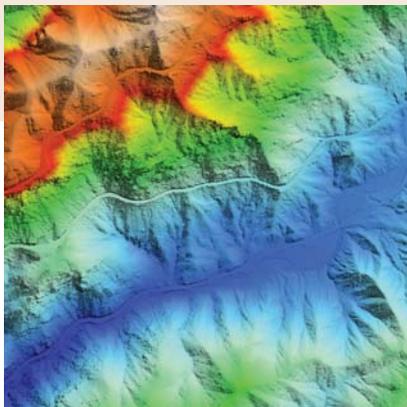
FEMA Compliant LiDAR

As a FEMA Map Modernization specific product, Sanborn's FEMA Compliant LiDAR product meets FEMA guidelines and specification for LiDAR-based elevation models. This product can be captured at 1 meter or 1.4 meter average point line spacing.

Typical uses for the dataset include:

- › FEMA Flood Plain Map Modernization programs
- › DFIRM map updates
- › Watersheds and other hydro studies per FEMA specifications
- › County mapping programs
- › Mapping programs that include accuracy verification, reporting and meta data
- › Suitable for use in creation of 2-foot accurate contours
- › Breaklining is optional

The Sanborn FEMA Compliant LiDAR product is furnished as a bare earth digital elevation model (DEM) and can be optionally upgraded to a digital terrain model (DTM) and/or contour product. All data and products associated with contract deliverables will meet or exceed relevant NSSDA standards and fully comply with the FGDC metadata format standard. Deliverables will be submitted to customer in digital format according to requirements outlined in the FEMA guidelines, Appendix A.



High Density LiDAR

High Density LiDAR is a project-specific, high accuracy and point concentrated data set. Sanborn's High Density LiDAR products meet most needs for LiDAR-based elevation models in very dense vegetation and terrain constrained areas.

Typical uses for the dataset include:

- › Heavily vegetated project areas
- › Remote and limited access project areas
- › Land development, transportation and other corridor projects
- › County mapping projects requiring sub-meter point postings
- › Terrain, forestry, and volumetric analysis
- › Utility and pipeline mapping projects
- › Change detection and 3-D modeling in dense urban areas
- › Breaklining is optional

Sanborn High Density LiDAR has been used in a variety of mapping applications and has grown dramatically as a result of advanced technology. The increased sample density has improved the statistical probability of more accurately defining a surface model and mapped structures. This product is delivered as a file of first returns, last returns, intensity, and bare earth digital elevation model (DEM), and can be optionally upgraded to a digital terrain model (DTM) and/or contour product.

Product Quality Statement

- › No data voids due to system malfunctions or lack of overlap
- › Dense vegetation data voids minimized by automatic removal process
- › Sanborn calibrates for every mission
- › Flight plan considers requirement for point density, terrain, PDOP, and KP index.

Technical Specifications

Standard LiDAR

- › 1.4 meter average point spacing
- › Scan frequency and angles based on project area terrain and land cover
- › **Vertical Accuracy:**
Bare-earth: 18.5cm RMSE
Vegetation: 37cm RMSE
- › **Horizontal Accuracy:**
one-meter RMSE
- › No independent field verification
- › Sanborn prepares flight plans as parallel flight lines with at least one cross flight line to assure positional accuracy and quality control.
- › Sanborn uses only automated filtering for Standard LiDAR products with the following minimum performance for bare-earth elevation models:
 - 89% of artifacts or more removed depending on terrain and vegetation
 - 90% of all outliers removed
 - 90% of all vegetation removed
 - 93% of all buildings removed

FEMA Compliant LiDAR

In addition to Standard LiDAR specifications:

- › Available as 1.4 or 1.0 meter average point spacing
- › Sanborn field verification
- › 3 classes, 20 points each
- › Sanborn flight plans are parallel flight lines with at least one cross flight line to assure positional accuracy and quality control, and collection verified with both kinematic and static collections.
- › Sanborn uses automated and manual filtering for LiDAR products with the following minimum performance for bare-earth elevation models:
 - 90% of artifacts or more removed depending on terrain and vegetation
 - 95% or better of all outliers removed
 - 95% of all vegetation removed
 - 98% of all buildings removed

High Density LiDAR

- › 0.7 meter average point spacing
- › Collection within 40km baseline
- › Scan frequency and angles based on project specification
- › **Vertical Accuracy:**
Bare-earth: 15cm RMSE
Vegetation: 27cm RMSE
- › **Horizontal Accuracy:**
0.5 meter RMSE
- › Sanborn flight plans are parallel flight lines with at least one cross flight line to assure positional accuracy and quality control, and collection verified with both kinematic and static collections.
- › Sanborn uses automated and manual filtering for High Density LiDAR products with the following minimum performance for bare-earth elevation models:
 - 95% of artifacts or more removed depending on terrain and vegetation
 - 98% of all outliers removed
 - 97% of all vegetation removed
 - 99% of all buildings removed

LiDAR Operating Principles

LiDAR (light detection and ranging) is a technology through which a laser is fired at the ground from an airplane to measure distance to the ground. LiDAR was developed as a fast and effective method to gather digital elevation model (DEM) data. With state-of-the-art Leica ALS50 (83kHz) and Optech ALTM 2050 (50kHz) LiDAR sensors, and many thousands of square miles of data successfully acquired and processed, Sanborn sets the highest standard of accuracy and reliability for LiDAR technology.

GPS Satellite



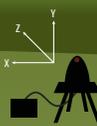
Aerial GPS (Global Positioning System)
GPS satellite triangulation measures the location of the aircraft up to every 0.1 second

Aerial LiDAR scanner

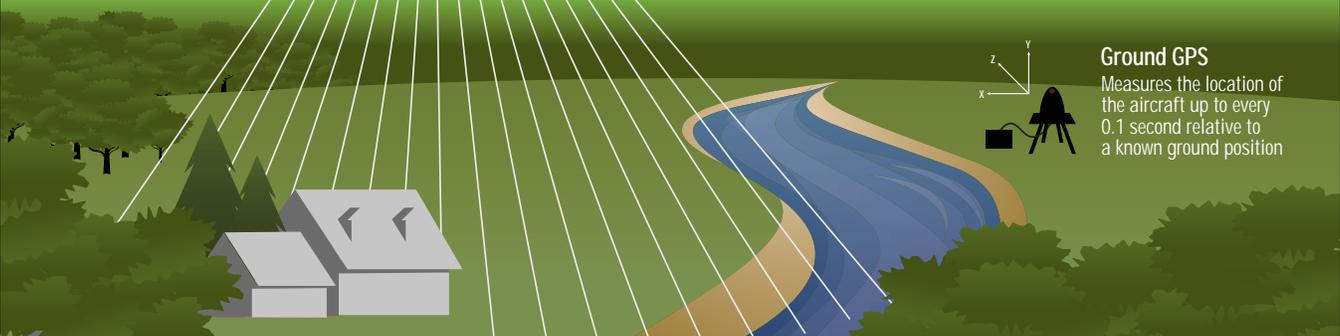
Sends/receives up to four returns per pulse using a laser transceiver, receiver, and scanner with variable frequency range



Aerial IMU (Inertial Measurement Unit)
Measures attitude (pitch/yaw/roll) of aircraft every .002 second

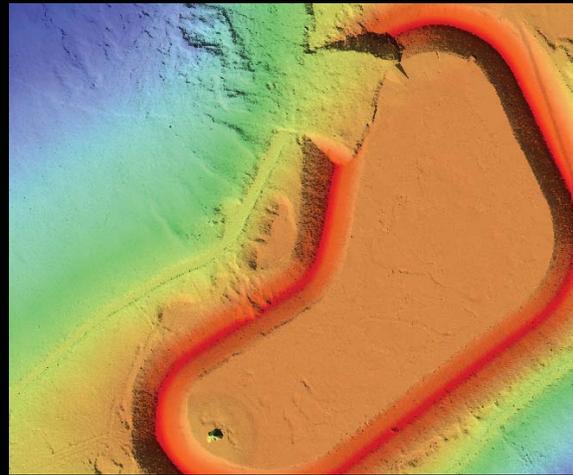


Ground GPS
Measures the location of the aircraft up to every 0.1 second relative to a known ground position

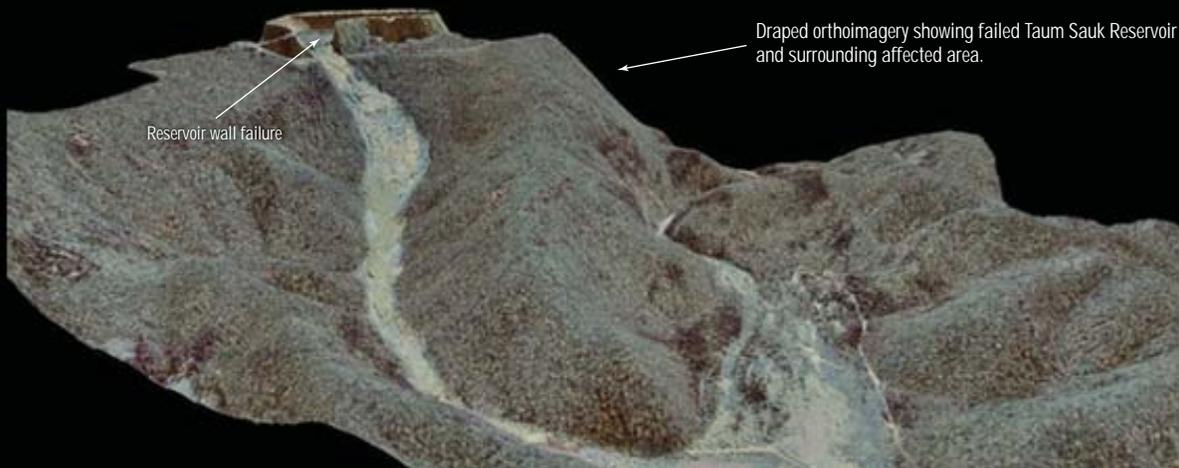




Orthoimagery of failed Taum Sauk Reservoir



LiDAR imagery of failed Taum Sauk Reservoir



Overtopping water at the AmerenUE's Taum Sauk Upper Storage Facility caused a massive dam failure during the pre-dawn hours of December 14th 2005. More than a billion gallons of water rushed down Proffit Mountain and overwhelmed the east fork of the Black River and the lower ground of Johnson's Shut-Ins State Park. The water swept the park superintendent's home, along with his family, a quarter-mile away and caused damage to several vehicles that were brushed off of a local highway into an adjacent field. According to calculations, the flow of water at the time would have been nearly 150,000 cubic feet per second, which is nearly equivalent to the rate water travels over Niagara Falls.

Deliverables

- › Firm delivery schedule to be defined at time of order (can be delivered within nine-weeks for a project area of approximately 500-600 square miles)
- › Standard coordinates, projections, and datums
- › Delivered in ASCII or LAS format (or both). The LAS deliverable is classified into the following categories: ground, unclassified, low point, and overlap. Raw point cloud is a free delivery option. For no additional fee, a Standard ARCGRID DEM or Standard ASCII GRID format can be provided. The ASCII format is an ASCII Bare Earth DEM format (the ground layer).

Additional LiDAR Options

- › Terrain refinement through breakline additions
- › Automated contours
- › High definition ground based LiDAR

About Sanborn

With a rich tradition of mapping dating back to 1866, Sanborn provides comprehensive end- to-end geospatial solutions. Sanborn offers products and services that satisfy diverse and evolving customer needs for GIS software systems, application development, systems integration, and spatial analysis and modeling. Leveraging precision remote sensing techniques, Sanborn also supports a wide range of applications and users. Sanborn's solutions are founded on a strong legacy of innovative geospatial data collection and processing capabilities. An internationally recognized company, Sanborn has multiple U.S. offices with customers worldwide. For more information, visit www.sanborn.com.