LiDAR ACQUISITION AND PROCESSING REPORT

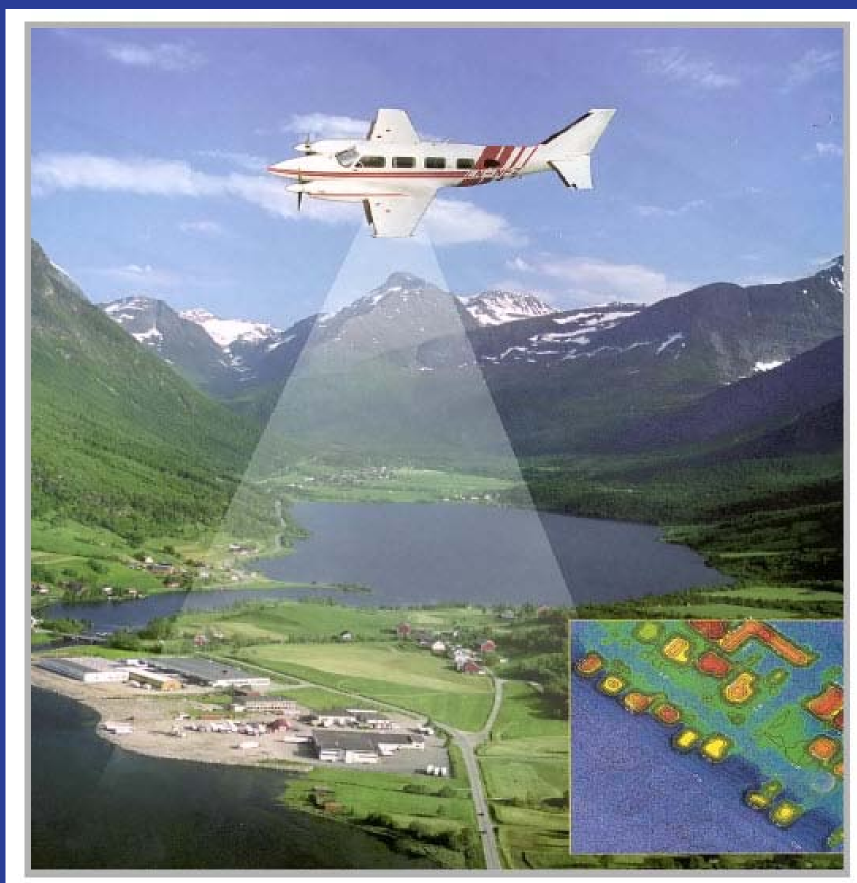
Project: 2012 LiDAR Project

Report Area: Area 1-D

URS Contract No.: 259352

Date: 11-June-2012

Submitted by: Wade Williams, Project Manager



Oklahoma NRCS

Project Overview

URS Group Inc. contracted with Surdex Corporation in the fall of 2011 to collect high resolution LiDAR elevation data over portions of east-central Oklahoma. The Oklahoma Natural Resources Conservation Service (NRCS) required an area totaling approximately 11,100 square miles of coverage. This report covers the collection of LiDAR data for 2,238 square miles in Area1-D. The average laser ground sample distance required for this project is 1.4 meters.

LIDAR Data Planning and Acquisition:

The following parameters were used in preparing the flight plan.

Flight altitude	2,700+/- meters AGL
Airspeed	170 knots
Full swath width	1,965 meters
Overlap between strips	20 % (average)
Field of View	40.0 degrees
Average Point Spacing	1.39 meters
Scan frequency	36.1 Hz
Pulse Repetition Rate	89,200 Hz
Returns per pulse	4 + intensity

LiDAR data was acquired leaf-off, snow-free and while water bodies are at below to normal levels by Surdex Corporation for Area1-D on January 2, 3, 4 & 14, 2012 (see attached flight map). Surdex utilized a Leica ALS-50-II multi-pulse instrument. The area was flown in five missions over four days. Surdex set up GPS base stations for all flights and also utilized the Oklahoma Department of Transportation (OKDOT) continuously operating reference stations (CORS) as well. All flight lines were flown within 25 miles of a GPS station.

The flight crew is guided by a GPS controlled flight management system, which displays the flight plan; including altitude, heading, cross track deviation and PDOP. During the flight mission, the system operator monitors flight management data, laser information, to ensure a successful mission.

Before and after each LiDAR mission, Surdex Corporation performed a calibration flight to ensure the accuracy of the data to be acquired. This calibration flight consisted of two sets of parallel lines flown in opposite directions, each set perpendicular to each other. These calibration lines were flown over the top of the base airfield and nearby buildings to observe if any horizontal or vertical offset was present. The results of the calibration flights are reviewed in relation to a recent, more rigorous bore sight calibration on the instrument.

All data in the aircraft, including GPS, IMU (inertial measurement unit, i.e. rotational angles); laser ranges; are recorded onto 72 GB removable hard drives and 1 GB flash memory cards. Upon landing the system operator removes all storage devices from the LIDAR system and the GPS receivers. At the end of each flight day, all data is copied to a second set of data drives for archival purposes. Two copies of all data are maintained throughout our entire process.

Data Processing

Post processing of LiDAR involves the following software packages and procedures:

1. IPAS Pro (Leica)
2. GrafNav (Waypoint)
3. ALS Post-Processor (Leica)
4. TerraScan and TerraModeller (TerraSolid)
5. GeoCue (NIIRS10)

The GPS data is processed, differentially corrected, and its integrity is verified. The IMU data is combined with the GPS and laser range data to create LIDAR elevation points in the project coordinate system. The LIDAR elevation point data are viewed as shaded relief elevation images by flight line. The data is compared with the project boundary and planned flight lines to verify complete data coverage. The flight line data is merged and any areas that that may not be covered with LIDAR are identified and re-flown before the flight crew leaves the project area.

After the data arrives from the field, it is immediately processed and verified. IMU data is processed and checked for gyro bias, systematic errors, and position error.

Based on the system calibration flight line, any alignment errors can be computed and corrected in the processing. The LIDAR elevation point data is projected to XYZ coordinates. First the data is edge matched in order to provide a seamless data set for further processing. Following verification of the daily calibration flight lines, all initial data processing of the LIDAR data is complete.

Ground Surface LIDAR Data Filtering:

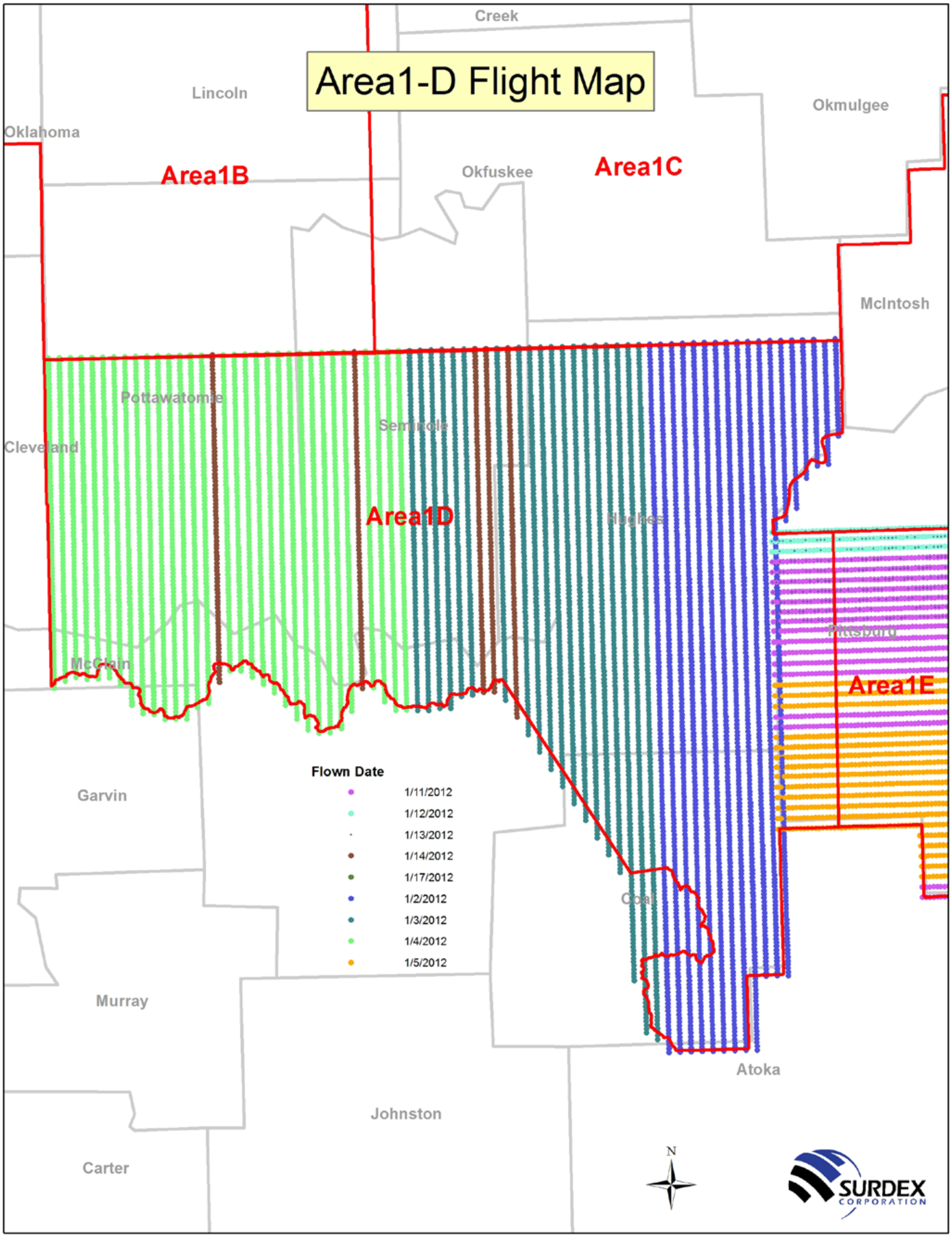
All LIDAR points are stored in a database that retains information about flight day and time, return number, laser scan angle, and other information. The database is reviewed and areas of like characteristics are delineated and flagged. The LIDAR processing group will determine which type of filtering techniques need to be applied to each type of area, to provide the best quality at ground elevation surface. Factors that affect this decision are slope, vegetation and cultural features. Each project has unique characteristics that can only be assessed after the data is collected. Data integrity is assured after visualizing results from the selected filtering techniques such as shaded relief models, 3-D viewers and elevation images.

Surdex used a combination of automated and manual filtering techniques for the creation of the bare-earth surface. A minimum 95% of the artifacts, outliers, voids, systematic and random errors, noise, anomalies, manmade features and vegetation were removed. The resulting digital terrain will support production of 2' contours for ASPRS Class I Standards. The final step involves output of data into LAS version 1.2 format. All final LAS data were projected into the following: UTM Zone 14 or 15 NAD83, NAVD88 Geoid09 meters using overlapping digital orthophoto quarter-quarter quadrangle (DOQQQ) footprints.

Create Digital Elevation Models

The final 2-meter Digital Elevation Models (DEM) were created once the data had been calibrated, edited and filtered using our workflows described above. This DTM represents the ground surface, interpolated using the gridded network from the bare earth surface. The DSM represents the first-return surface interpolated using the gridded network. Finally ESRI geodatabase raster mosaics were created using the bare-earth & first-return grid files.

All final ESRI Grid DEM files were generated into the following two projections: UTM Zone 14 or 15 NAD83, NAVD88 Geoid09, meters using overlapping digital orthophoto quarter-quarter quads (DOQQQ).



Area1-D Flight Map
Creek
Lincoln
Okmulgee
Oklahoma
Area1B
Okfuskee
Area1C
McIntosh
Pottawatomie
Seminole
Cleveland
Area1D
Hughes
Pittsburg
McClain
Area1E
Flown Date
1/11/2012
1/12/2012
1/13/2012
1/14/2012
1/17/2012
1/2/2012
1/3/2012
1/4/2012
1/5/2012
Garvin
Coal
Murray
Atoka
Johnston
Carter
N
SURDEX
CORPORATION