WSI Applied Remote Sensing and Analysis

OLC Lane County: Delivery 6

Data collected for:
Oregon Department of Geology and Mineral Industries

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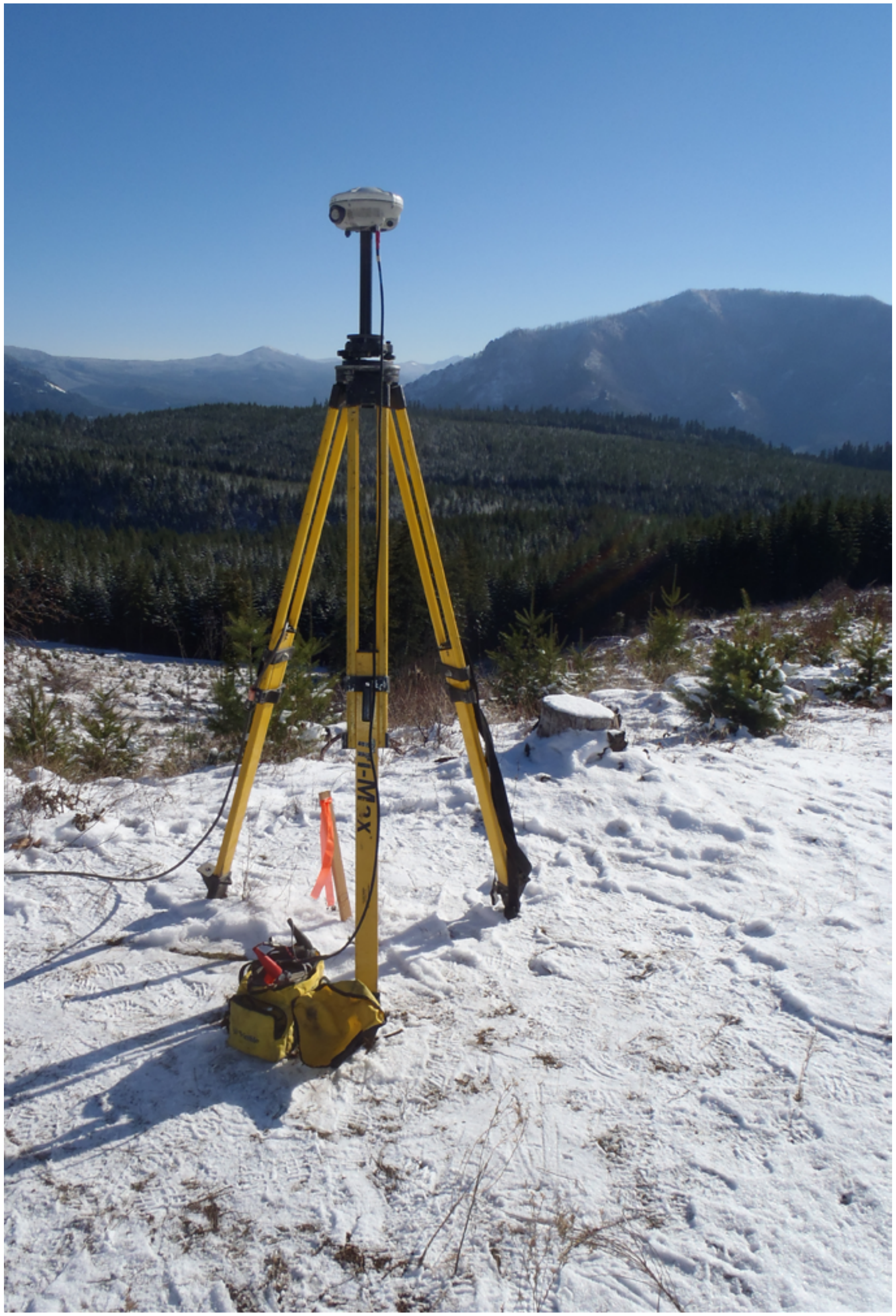


Trimble R8 Reciever set up over GPS Monument "Lane_27," December 4, 2013.

Project Overview

WSI has completed the acquisition and processing of Light Detection and Ranging (LiDAR) data and Four-Band Radiometric Image Enhanced Survey (FRIES) of the OLC Lane County Delivery Area Six, for the Oregon Department of Geology and Mineral Industries (DOGAMI). The Oregon LiDAR Consortium's Lane County project area of interest (AOI) encompasses 1,640,978 acres. Delivery Area Six encompasses 198,377 acres.

The collection of high resolution geographic data is part of an ongoing pursuit to amass a library of information accessible to government agencies as well as the general public.

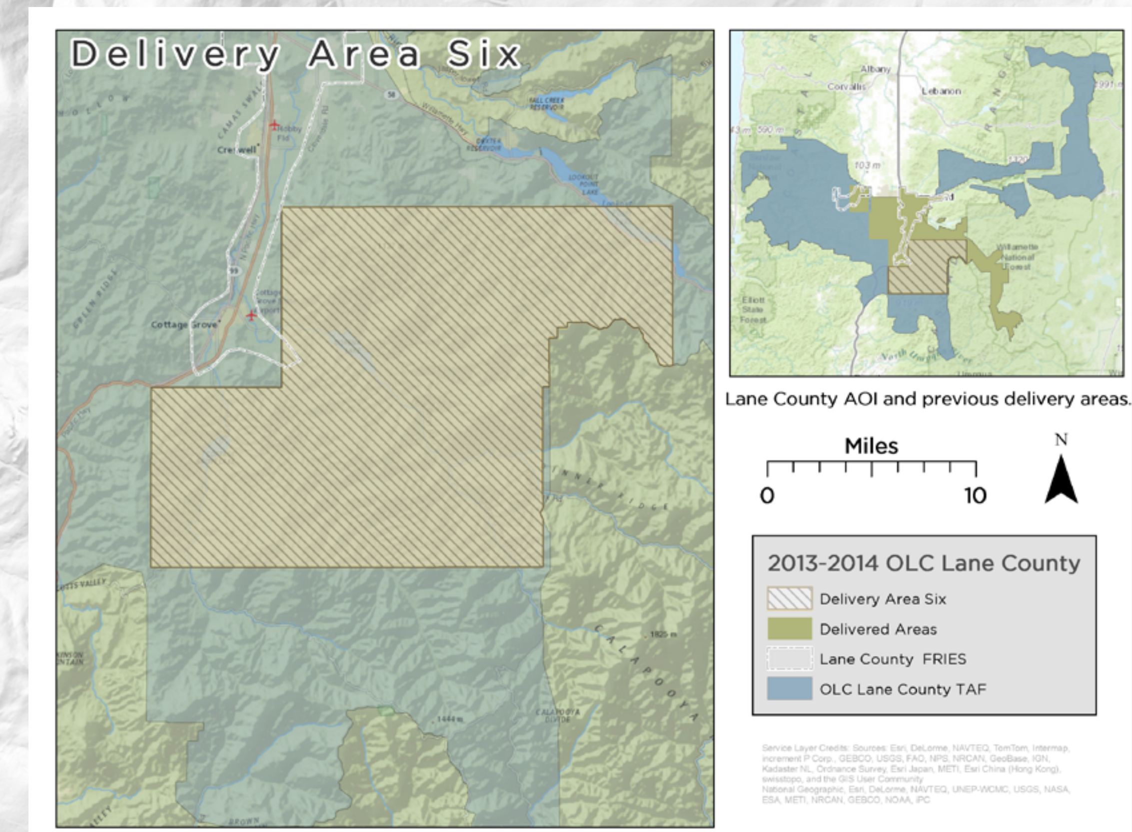
WSI began data collection on September 5, 2013 for the Lane County project and collection is currently ongoing contingent upon weather. Settings for LiDAR data capture produced an average resolution of at least eight pulses per square meter.

Final products created include LiDAR point cloud data, three-foot digital elevation models of bare earth ground model and highest-hit returns, 1.5-foot intensity rasters, 3-inch orthophotos, ground density rasters, study area vector shapes, and corresponding statistical data.

WSI acquires and processes data in the most current, NGS-approved datums and geoid. For OLC Lane county, all final deliverables are projected in Oregon Lambert, endorsed by the Oregon Geographic Information Council (OGIC),[1] using the NAD83(2011) horizontal datum and the NAVD88 (Geoid 12A) vertical datum, with units in International feet.

OLC Lane County AOI Data Delivered December 19, 2014	
Acquisition Dates	November 27 - 28, 2013 December 4, 2013 January 6 - 26, 2014 June 4- 22, 2014 July 4-7, 2014
Delivery Area Six Area of Interest	198,377 acres
Projection	Oregon Lambert
Datum: horizontal & vertical	NAD83 (2011) NAVD88 (Geoid 12A)
Units	International Feet

Study Area



1 http://www.oregon.gov/DAS/EISPD/GEO/pages/coordination/projections/projections.aspx

Aerial Acquisition

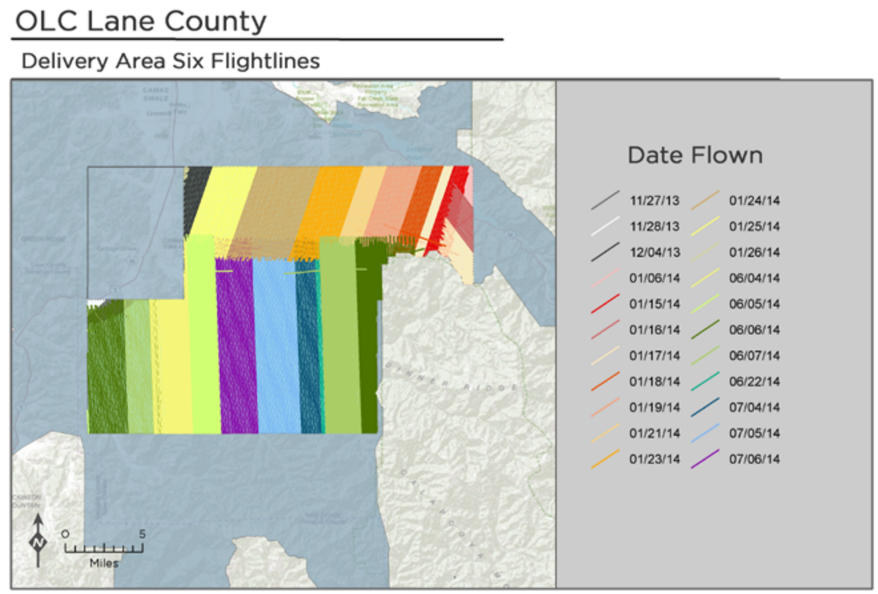
Cessna Caravan

LiDAR Survey

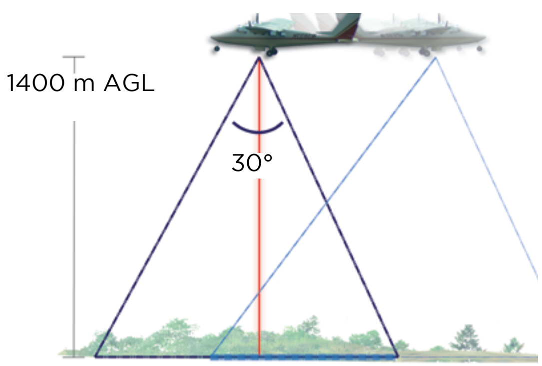
The LiDAR survey utilized both Leica ALS70 and ALS50 sensors mounted in a Cessna Caravan 208B and Piper PA-31 respectively. The systems were programmed to emit single pulses at a rate of 190 to 198 kilohertz and flown at 1,400 meters or 900 meters above ground level (AGL), capturing a scan angle of +/-15 degrees from nadir (field of view equal to 30 degrees). These settings are developed to yield points with an average native density of greater than eight pulses per square meter over terrestrial surfaces.

The native pulse density is the number of pulses emitted by the LiDAR system. Some types of surfaces such as dense vegetation or water may return fewer pulses than the laser originally emitted. Therefore, the delivered density can be less than the native density and lightly vary according to distributions of terrain, land cover, and water bodies. The study area was surveyed with opposing flight line side-lap of greater than 65 percent with at least 100 percent overlap to reduce laser shadowing and increase surface laser painting. The system allows up to four range measurements per pulse, and all discernible laser returns were processed for the output dataset.

To solve for laser point position, it is vital to have an accurate description of aircraft position and attitude. Aircraft position is described as x, y, and z and measured twice per second (two hertz) by an onboard differential GPS unit. Aircraft attitude is measured 200 times per second (200 hertz) as pitch, roll, and yaw (heading) from an onboard inertial measurement unit (IMU). As illustrated in the accompanying map, 553 flightlines provide coverage of the study area.



Project Flightlines



Lane County Acquisition Specifications	
Sensors Deployed	Leica ALS 50 and Leica ALS 70
Aircraft	Cessna Caravan 208B, Piper PA 31
Survey Altitude (AGL)	1400 m / 900 m
Pulse Rate	190-198 kHz
Pulse Mode	Single (SPiA)
Field of View (FOV)	30°
Roll Compensated	Yes
Overlap	100% overlap with 65% sidelap
Pulse Emission Density	≥ 8 pulses per square meter

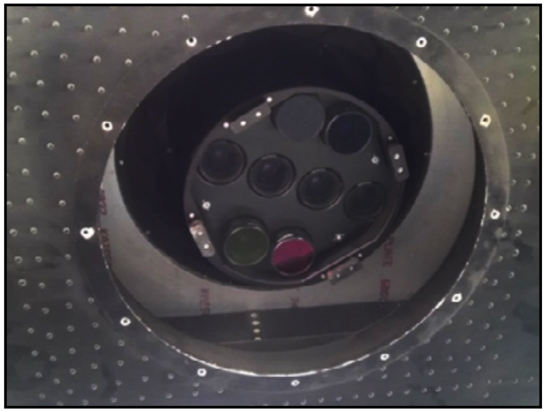
Aerial Acquisition

Photography

The photography or Four-Band Radiometric Image Enhanced Survey (FRIES) utilized an UltraCam Eagle 260 megapixel camera mounted in a Cessna 208B Caravan. The UltraCam Eagle is an 80 mm, 260 megapixel large format digital aerial camera manufactured by the Microsoft Corporation. The system is gyro-stabilized and contains a fully integrated UltraNav flight management system with a POS-AV 510 IMU embedded within the body of the camera unit.

The Eagle was designed with high efficiency, high resolution, and high accuracy in mind. With a physical pixel size of 5.2 microns, the Eagle captures a 6.5 cm ground sample distance (GSD) at a flying height of 1,000 meters AGL. This sensor size of the camera is 20,010 x 13,080 pixels in size, which allows for total ground coverage of 1300 x 850 meters within a single captured image frame at 1,000 meters AGL. This large footprint coupled with a fast frame rate (1.8 seconds per frame) allows for highly efficient acquisition. The precise integrated UltraNav system is accurate enough for direct georeferencing in many applications.

The UltraCam Eagle simultaneously collects panchromatic and multispectral (RGB, NIR) imagery in 14 bit format. The spectral sensitivity of the panchromatic charged coupled device (CCD) array ranges from 400-720 nm, with 16,000 grey values per pixel. Four separate 27 mm lenses collect red (590-720 nm), green (490-660 nm), blue (410-590 nm) and near infrared (690-990 nm) light. Panchromatic lenses collect high resolution imagery by illuminating nine CCD arrays, writing nine raw image files. RGB and NIR lenses collect lower resolution imagery, written as four individual raw image files. Level 2 images are created by stitching together raw image data from the nine panchromatic CCDs, and ultimately combined with the multispectral image data to yield Level 3 pan-sharpened TIFFs in either 8 bit format.



Above: UltraCam Eagle lens configuration as viewed from the Cessna Caravan.

Above: A Cessna Grand Caravan 208B was employed in the collection of all orthoimagery.

Below: UltraCam Eagle installed in the aircraft.

Orthophoto Processing

Within the UltraMap software suite, raw acquired images are radiometrically and geometrically corrected using the camera's calibration files and output as Level 2 images. The resulting radiometry is then manually edited to ensure each image has the appropriate tone, no pixels are clipped, and to blend each image with its neighbors. Once radiometry has been edited, separate RGBI and panchromatic images are blended together to form single level 3 pan-sharpened 4 band TIFF images.

The kinematic GPS positional data is post-processed in office, using static monument coordinates from base stations that were occupied for a minimum of 6 hours and were running during the time of acquisition. Photo position and orientation are calculated by linking the time of image capture, the corresponding aircraft position and attitude, and the smoothed best estimate of trajectory (SBET) data in POSPac MMS, and outputting an initial Exterior Orientations (EO) file.

The EO file is combined with level 3 TIFFs within the Inpho software suite to place the images frames spatially. Aerial triangulation is performed to tie the image frames to each other, and to align them with surveyed ground control coordinates. A point cloud ground model is generated from the image frames by finding matching pixels between images and calculating the coordinates of each extracted point. Triangulated image frames are then draped onto a DEM, derived from the extracted point cloud and orthorectified. Individual orthorectified tiffs are blended together to remove seams and corrected for any remaining radiometric differences between images using Inpho's OrthoVista. The 4-Band image mosaic is tiled to create a usable GeoTIFF raster product.

The 4-band GeoTIFF format allows for flexibility in image analysis and display. By adjusting the image band setup to display the near infrared spectral band as red (this display is known as color-infrared), vegetation stands out extremely vividly in the orthophoto mosaic.

Digital Orthophotography Survey Specifications	
Aircraft	Cessna 208-B Grand Caravan
Sensor	UltraCam Eagle
Altitude	1,846 m AGL
GPS Satellite Constellation	6
GPS PDOP	3.0
GPS Baselines	≤ 13 nm
Image	8-bit GeoTIFF
Along Track Overlap	60%
Spectral Bands	Red, Green, Blue, NIR
Resolution	3 in. pixel size

Below: Trimble R7 set up over "Lane_32".

Aerial Targets

Prior to photo acquisition, permanent and temporary aerial photo targets were located and installed throughout the study area. The air targets were set within two miles of a GPS base location and target control points (TCPs) were collected at each corner of the target, as well as the center point, for utilization in the processing and quality control of the orthophoto deliverables.

Because temporary air targets are subject to possible outside influences (e.g., weather, curious public, wildlife), WSI identifies locations adequate for collection of TCPs that are on permanent features. Selected locations include existing aerial targets, turn-arrows, STOP bars, etc. that are visible from the aircraft. WSI also paints permanent targets in appropriate locations when necessary. Additional permanent air targets were identified in the field and used for processing orthophotos.

All TCPs were acquired using one of two methods. The air targets that were set within two miles of a GPS base location had TCPs collected at each corner of the target as well as the center point. In order to increase TCP sample size for data quality, WSI also used a Fast-Static (FS) survey technique by baseline post-processing. For the air targets that were set this way, WSI collected a single static session with the R8 rover set over the center point of the target. The FS sessions lasted 15-30 minutes, depending on the distance from the air target to the base station. The static sessions and the concurrent R7 base session data were later processed in Trimble Business Center software. The use of post processing eliminates the need to deal with radio link issues, and fast static methodology generally results in precision equal to or better than full RTK collection on each target.

Examples of permanent air targets.

Ground Survey

Ground control surveys, including monumentation, aerial targets, and ground check points (GCPs) were conducted to support the airborne acquisition. Ground control data are used to geospatially correct the aircraft positional coordinate data and to perform quality assurance checks on final LiDAR data and orthoimagery products. See the table below for specifications of equipment used.

Instrumentation

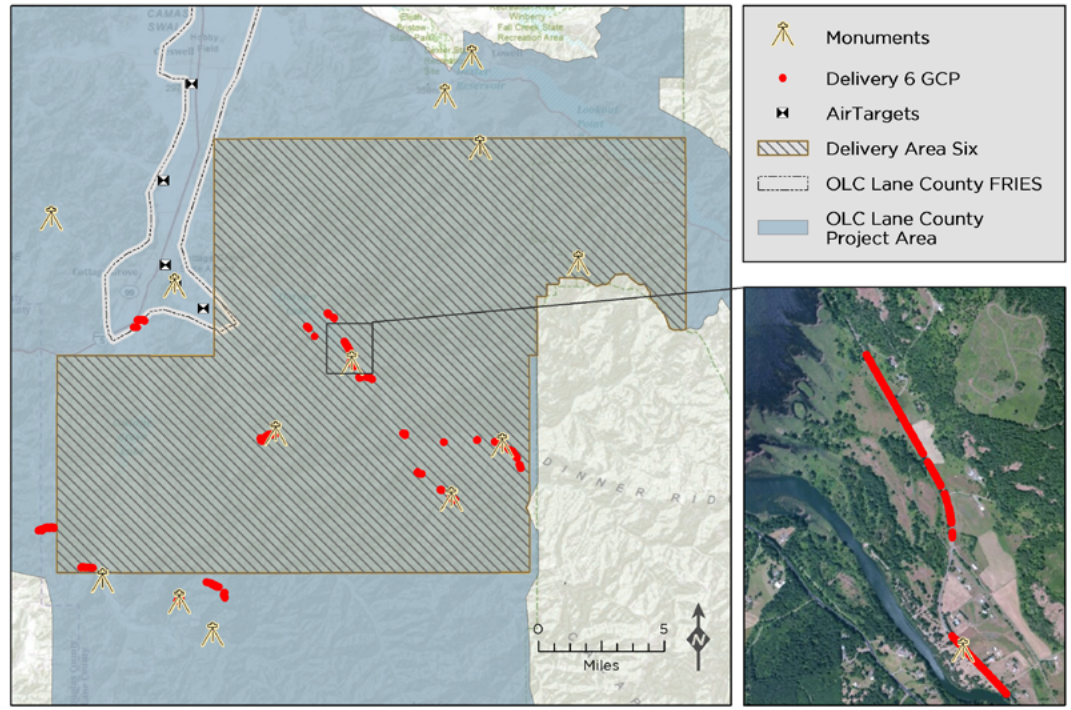
All Global Navigation Satellite System (GNSS) static surveys utilized Trimble R7 GNSS receivers with Zephyr Geodetic Model 2 RoHS antennas and Trimble R8 GNSS receivers with internal antennas. Rover surveys for GCP collection were conducted with Trimble R8 and Trimble R10 GNSS receivers.

Monumentation

Existing and newly established survey benchmarks serve as control points during LiDAR acquisition. Monument locations were selected with consideration for satellite visibility, field crew safety, and optimal location for GCP coverage. NGS benchmarks are preferred for control points; however, in the absence of NGS benchmarks, WSI produces our own monuments, and every effort is made to keep them within the public right of way or on public lands. If monuments are necessary on private property, consent from the owner is required. All monumentation is done with 5/8" x 30" rebar topped with a two-inch diameter aluminum cap stamped "Watershed Sciences, Inc. Control." The table at right provides the list of monuments used in Delivery Area Six. See Appendix B for a complete list of monuments placed within the OLC Lane County 2014 Study Area.

OLC Lane County

Delivery Area Six Ground Control



Delivery Area Six Monuments			
PID	Latitude	Longitude	Ellipsoid Height (m)
LANE_29A	43° 52' 12.08161"	-122° 47' 18.45256"	420.361
LANE_35	43° 48' 11.57911"	-122° 42' 37.56859"	1041.596
LANE_39	43° 42' 19.93987"	-122° 57' 05.04012"	456.450
LANE_41	43° 44' 45.10607"	-122° 53' 27.75969"	236.302
LANE_42	43° 40' 03.45665"	-122° 48' 42.76721"	311.004
LANE_49	43° 41' 54.47511"	-122° 46' 16.97790"	331.018

Methodology

Monument Accuracy	
FGDC-STD-007.2-1998 Rating	
St Dev NE	0.05 m
St Dev z	0.05 m

To correct the continuously recorded aircraft position, WSI concurrently conducts multiple static GNSS ground surveys over each monument. All control monuments are observed for a minimum of two survey sessions, each lasting no fewer than two hours. Data are collected at a rate of one hertz, using a 10 degree mask on the antenna. The static GPS data are then triangulated with nearby Continuously Operating Reference Stations (CORS) using the Online Positioning User Service (OPUS) for precise positioning.

Ground Check Points (GCPs) are collected using Real Time Kinematic (RTK), Post-Processed Kinematic (PPK), and Fast-Static (FS) survey techniques. For RTK surveys, a base receiver is positioned at a nearby monument to broadcast a kinematic correction to a roving receiver; for PPK and FS surveys, however, these corrections are post-processed. All GCP measurements are made during periods with a Position Dilution of Precision (PDOP) no greater than 3.0 and in view of at least six satellites for both receivers. Relative errors for the position must be less than 1.5 centimeters horizontal and 2.0 centimeters vertical in order to be accepted.

In order to facilitate comparisons with high quality LiDAR data, GCP measurements are not taken on highly reflective surfaces such as center line stripes or lane markings on roads. GCPs are taken no closer than one meter to any nearby terrain breaks such as road edges or drop offs. GCPs were collected within as many flight lines as possible; however, the distribution depended on ground access constraints and may not be equitably distributed throughout the study area.

Ground professional collecting RTK

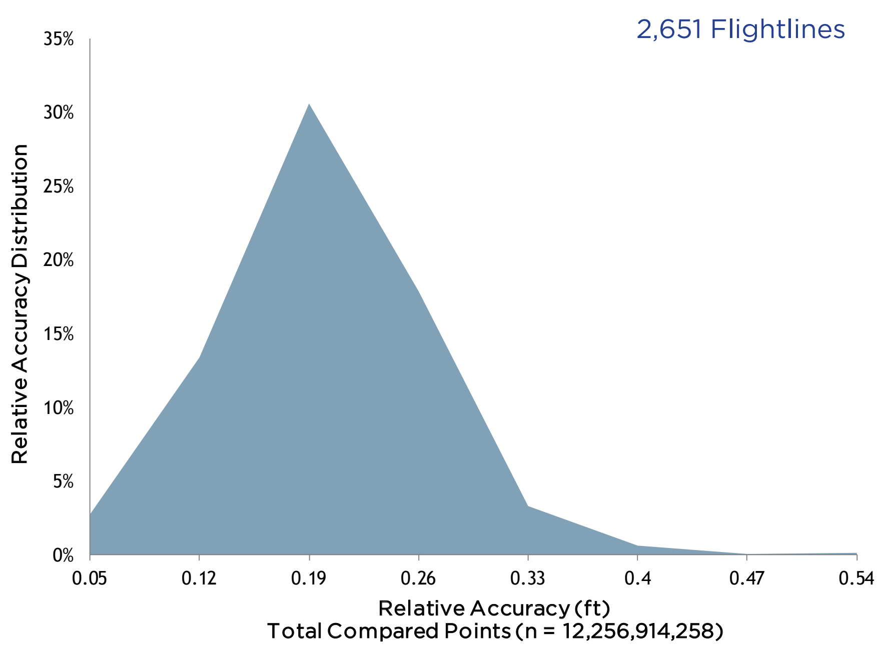
LiDAR Accuracy

Relative Accuracy

Relative accuracy refers to the internal consistency of the data set and is measured as the divergence between points from different flightlines within an overlapping area. Divergence is most apparent when flightlines are opposing. When the LiDAR system is well calibrated the line to line divergence is low (<10 centimeters). Internal consistency is affected by system attitude offsets (pitch, roll, and heading), mirror flex (scale), and GPS/IMU drift.

Relative accuracy statistics are based on the comparison of 2,651 full and partial flightlines (553 full and partial flightlines from Delivery Area Six) and over 12 billion points. Relative accuracy is reported for the cumulative delivered portions of the study area.

Relative Accuracy Distribution



Relative Accuracy Calibration Results N = 2,651 flightlines	
Project Average	0.17 ft. (0.05 m)
Median Relative Accuracy	0.17 ft. (0.05 m)
1σ Relative Accuracy	0.19 ft. (0.06 m)
2σ Relative Accuracy	0.27 ft. (0.08 m)


R7 Receiver

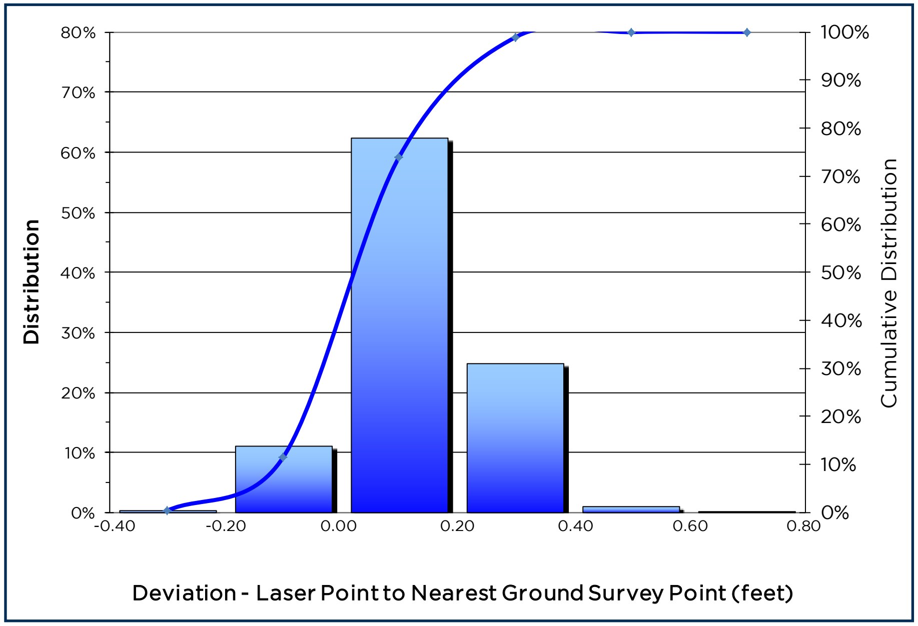
Vertical Accuracy

Vertical Accuracy reporting is designed to meet guidelines presented in the National Standard for Spatial Data Accuracy (NSSDA) (FGDC, 1998) and the ASPRS Guidelines for Vertical Accuracy Reporting for LiDAR Data V1.0 (ASPRS, 2004). The statistical model compares known ground check points to the triangulated LiDAR surface. Vertical accuracy statistical analysis uses ground control points in open areas where the LiDAR system has a "very high probability" that the sensor will measure the ground surface and is evaluated at the 95th percentile. For the Lane County Delivery six study area, 2,607 GCPs were collected. Statistics are shown for Delivery Area Six.

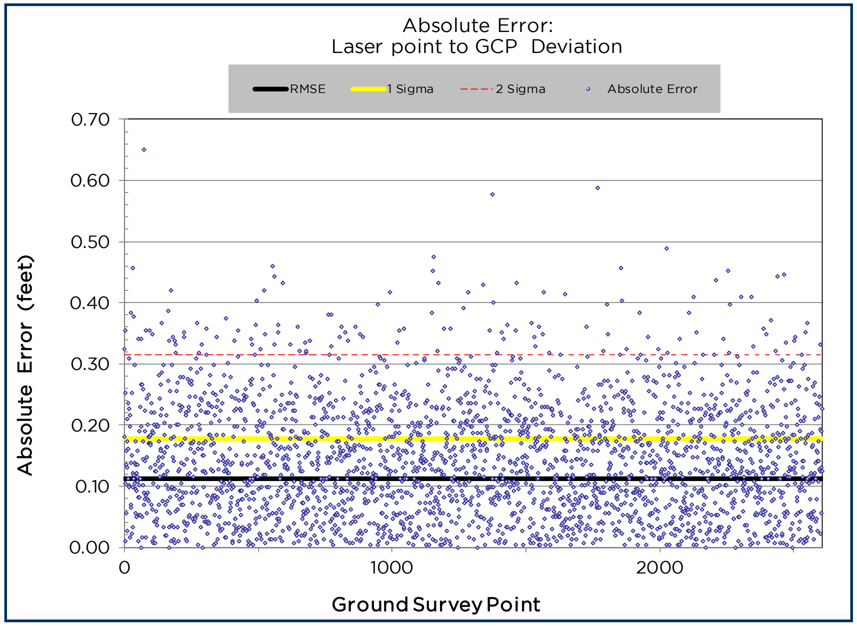
For this project, no independent survey data were collected, nor were reserved points collected for testing. As such, vertical accuracy statistics are reported as "Compiled to Meet." Vertical Accuracy is reported for the entire study area and reported in the table below. Histogram and absolute deviation statistics displayed below.

Vertical Accuracy Results		
	Delivery Area Six	Cumulative
Sample Size (n)	2,607 Ground check points	7,062 Ground check points
Root Mean Square Error	0.11 ft. (0.03 m)	0.09 ft. (0.03 m)
1 Standard Deviation	0.18 ft. (0.05 m)	0.09 ft. (0.03 m)
2 Standard Deviation	0.31 ft. (0.10 m)	0.18 ft. (0.06 m)
Average Deviation	-0.13 ft. (0.04 m)	-0.02 ft. (0.00 m)
Minimum Deviation	-0.37 ft. (-0.11 m)	-0.55 ft. (-0.17 m)
Maximum Deviation	0.65 ft. (0.20 m)	0.42 ft. (0.13 m)

Vertical Accuracy Distribution



GCP Absolute Error



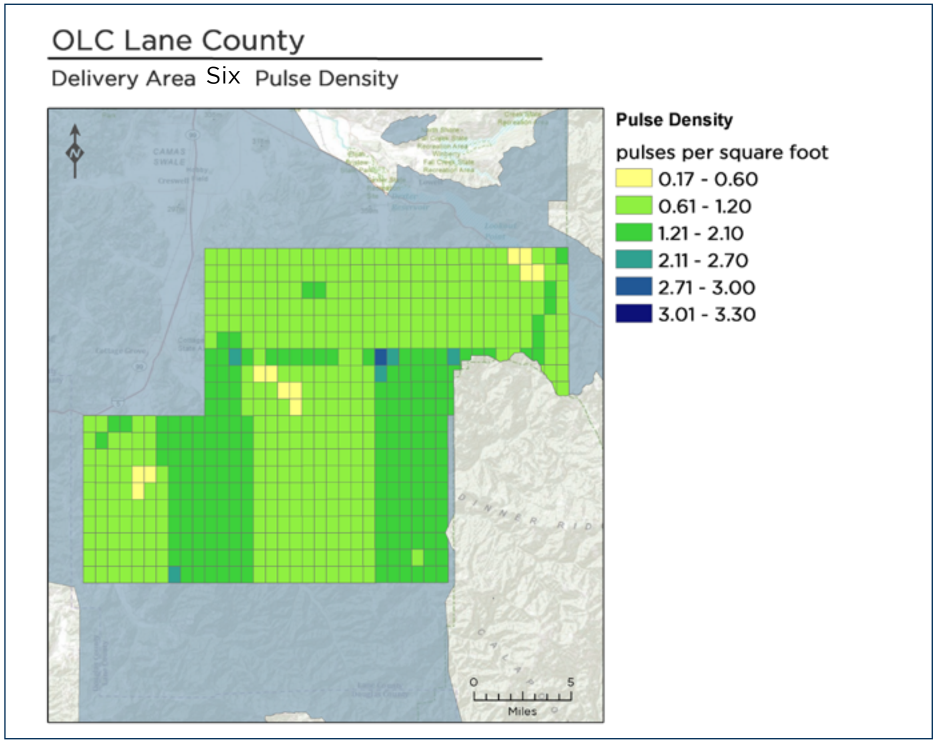
Density

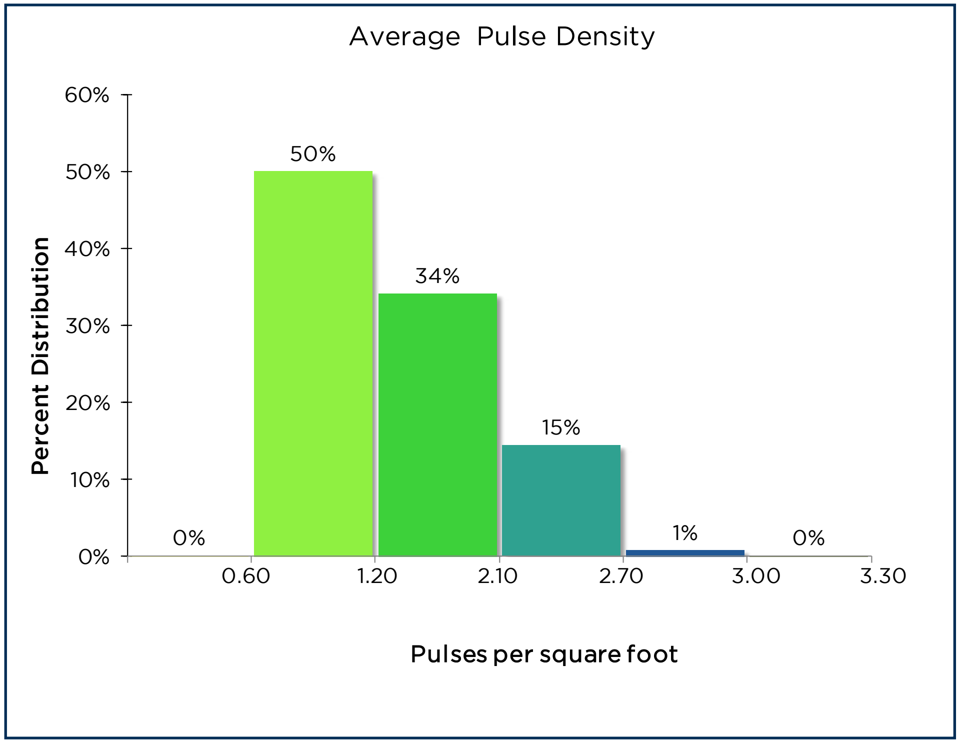
Pulse Density

Final pulse density is calculated after processing and is a measure of first returns per sampled area. Some types of surfaces (e.g., dense vegetation, water) may return fewer pulses than the laser originally emitted. Therefore, the delivered density can be less than the native density and vary according to terrain, land cover, and water bodies. Density histograms and maps have been calculated based on first return laser pulse density and ground-classified laser point density. Densities are reported for the delivery area.

Average Pulse Density	pulses per square meter	pulses per square foot
	11.42	1.06

Average Pulse Density per 0.75' USGS Quad (color scheme aligns with density chart).



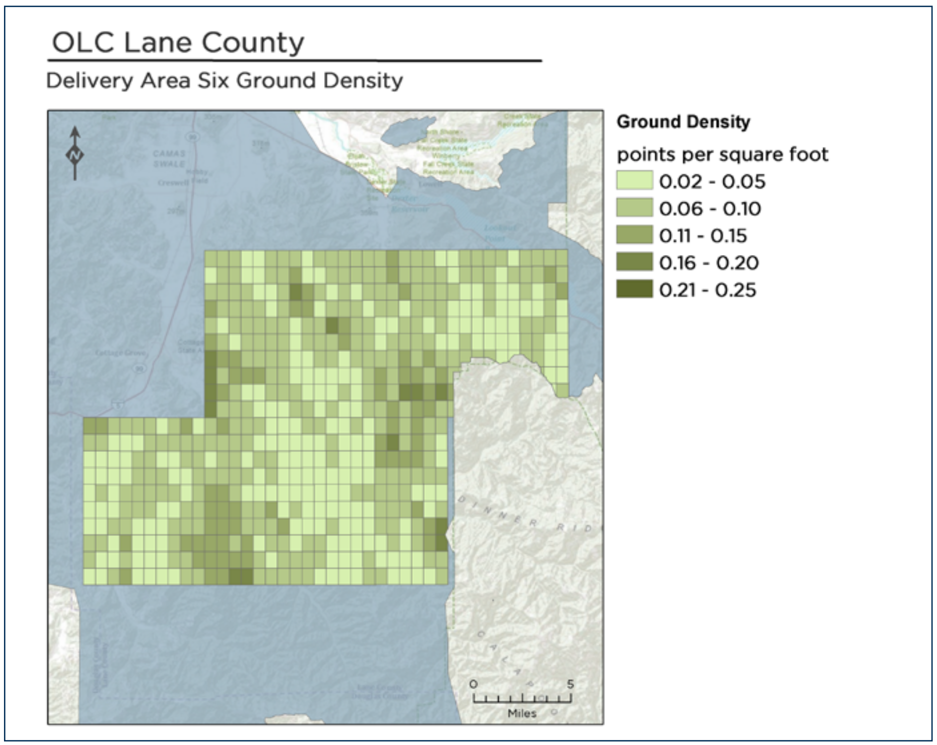


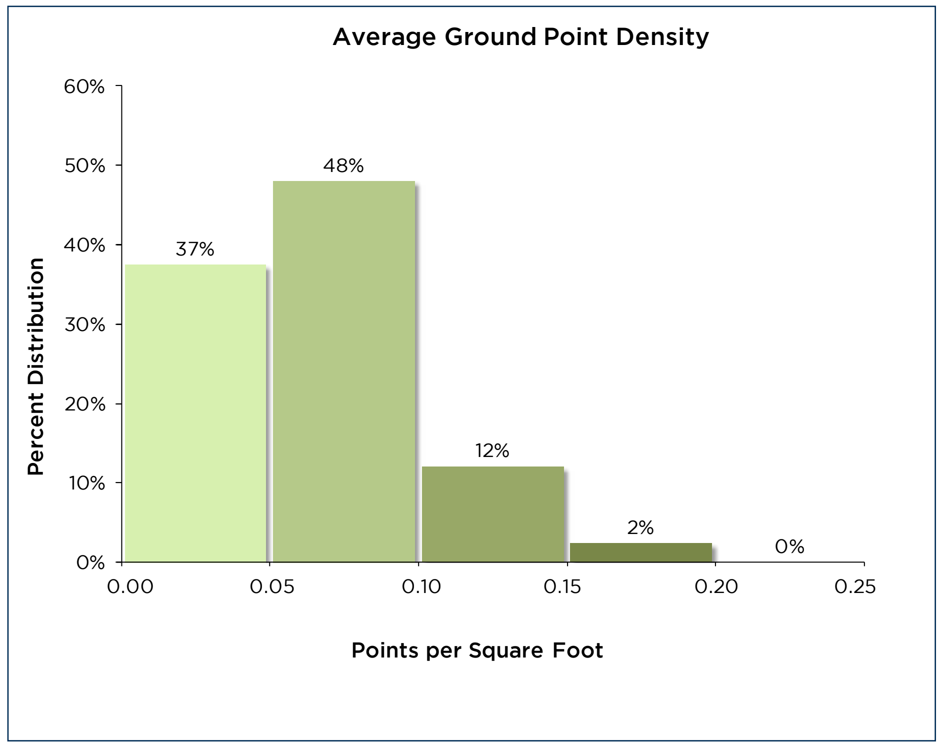
Ground Density

Ground classifications were derived from ground surface modeling. Further classifications were performed by reseeding of the ground model where it was determined that the ground model failed, usually under dense vegetation and/or at breaks in terrain, steep slopes, and at tile boundaries. The classifications are influenced by terrain and grounding parameters that are adjusted for the dataset. The reported ground density is a measure of ground-classified point data for the the delivery area.

Ground Density	points per square meter	points per square foot
	0.72	0.07

Average Ground Density per 0.75' USGS Quad (color scheme aligns with density chart).





Orthophoto Accuracy

Orthophoto Accuracy Assessment

To assess the spatial accuracy of the orthophotographs, artificial check points were established. Thirteen target control points, distributed evenly across the total acquired area, were generated on permanent air target surface features, such as painted road lines and fixed high-contrast objects or on temporary air targets. They were then compared against check points identified from the LiDAR intensity images. The accuracy of the final mosaic was calculated in relation to the LiDAR-derived check points and is listed below. Accuracy statistics are reported for the entire Lane County Orthophoto AOI.

Above: Example of co-registration of color images with LiDAR intensity images. **Below:** Examples of permanent air targets located within the Lane County project area.

Orthophoto horizontal accuracy results.

Orthophoto Horizontal Accuracy (n=13)	WSI Achieved (m)	WSI Achieved (ft.)
RMSE	0.110	0.360
1 Sigma	0.118	0.388
2 Sigma	0.187	0.612

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Appendix A : PLS Certification

WSI provided LiDAR Services for OLC Lane County LiDAR project Delivery 6 as described in this report.

I, John English, have reviewed the attached report for completeness and herby state that it is a complete and accurate report of this project.

12/19/2014

John English
Project Manager
WSI, a Quantum Spatial Company

I, Christopher Glantz, being duly registered as a Professional Land Surveyor in the state of Oregon, say that I hereby certify the methodologies and results of the attached LiDAR project, and that Static GNSS occupations on the Base Stations during airborne flights and RTK survey on hard-surface and GCP's were performed using commonly accepted Standard Practices. Field work conducted for this report was conducted between November 27, 2014 and July 7, 2014. Accuracy statistics shown in the Accuracy Section of this Report have been review by me and found to meet the "National Standard for Spatial Data Accuracy".

12/18/2014

Christopher Glantz, PLS
Land Surveyor
WSI, a Quantum Spatial Company
Portland, OR 97204

REGISTERED PROFESSIONAL LAND SURVEYOR
OREGON
JUNE 2, 2010
CHRISTOPHER A. GLANTZ
83648
RENEWS 6/30/2015

Appendix B : GPS Monument Table

List of GPS monuments used in Lane County Survey Area.

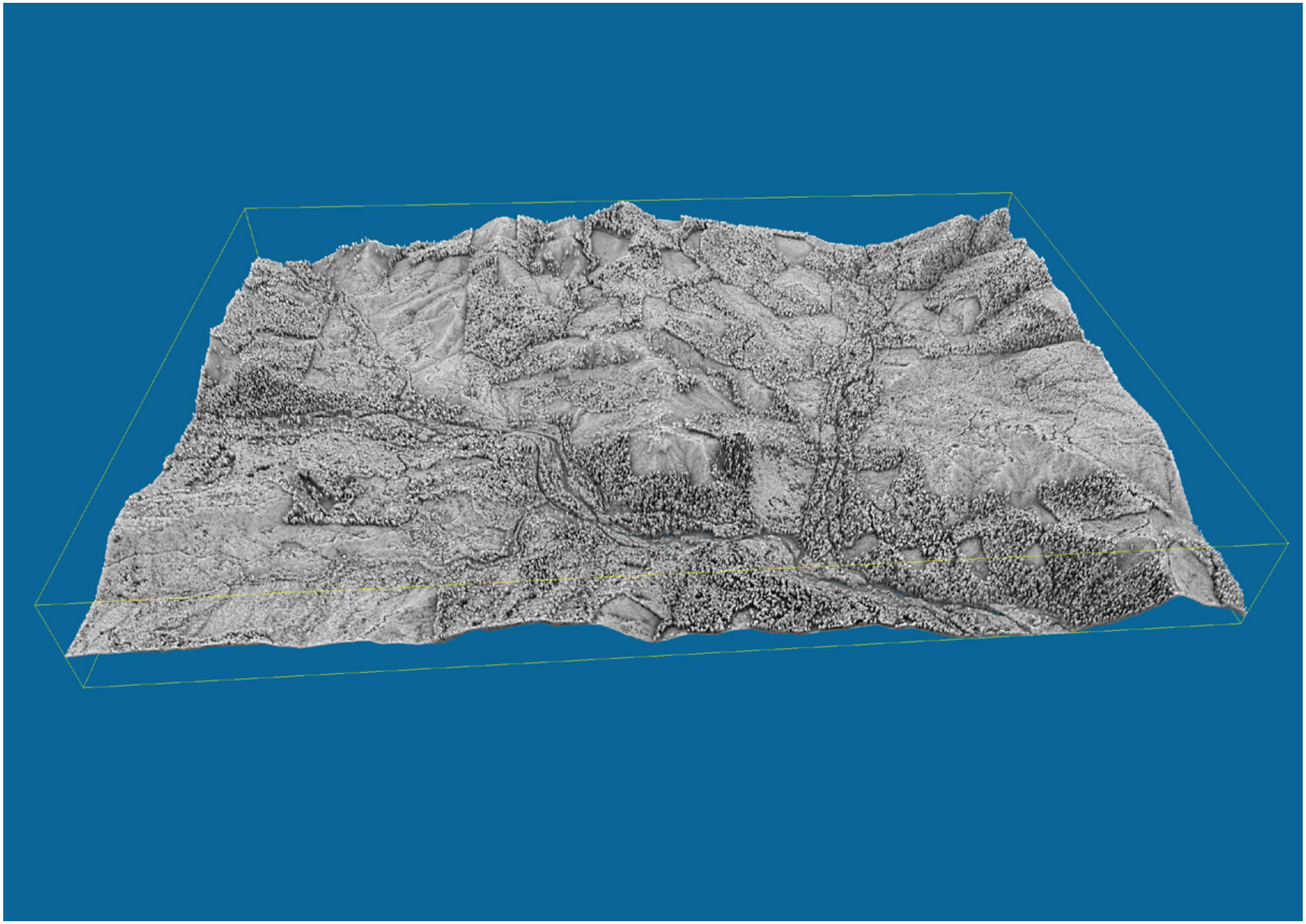
Lane County GPS Monuments			
PID	Latitude	Longitude	Ellipsoid Height (m)
LANE_01	44° 13’ 34.22103”	-123° 55’ 25.99216”	487.832
LANE_02	44° 11’ 04.59366”	-123° 51’ 03.90195”	104.844
LANE_05	44° 16’ 43.86859”	-124° 02’ 41.13217”	458.248
LANE_11	44° 04’ 08.74341”	-122° 48’ 06.59661”	161.587
LANE_13	44° 00’ 41.08475”	-122° 59’ 27.48519”	119.047
LANE_15	43° 59’ 28.97732”	-122° 56’ 10.19436”	139.378
AI1995	44° 01’ 06.96543”	-123° 51’ 37.53642”	-15.700
LANE_07	43° 59’ 52.25896”	-123° 22’ 23.48186”	143.322
LANE_09	44° 04’ 26.42150”	-123° 30’ 21.24330”	133.059
LANE_17	43° 59’ 22.07068”	-123° 11’ 07.80197”	111.693
LANE_19	44° 00’ 01.44296”	-123° 13’ 56.62771”	104.781
LANE_14	43° 50’ 13.64839”	-123° 14’ 03.11154”	175.699
LANE_16	43° 49’ 45.78726”	-123° 07’ 47.74145”	212.747
LANE_06	44° 12’ 10.80761”	-123° 30’ 31.42667”	196.503
LANE_08	44° 08’ 23.10388”	-123° 35’ 55.56664”	168.733
LANE_22	43° 52’ 51.72856”	-123° 13’ 33.92296”	147.785
LANE_23	43° 47’ 25.93196”	-123° 01’ 54.25135”	176.209
LANE_24	43° 42’ 26.18996”	-122° 25’ 40.56001”	450.794
LANE_25	43° 42’ 51.38283”	-122° 23’ 45.43363”	792.318
LANE_26	43° 33’ 00.45694”	-122° 28’ 22.66794”	815.341
LANE_27	43° 31’ 20.08417”	-122° 20’ 15.46234”	1080.075
LANE_30	43° 37’ 14.50986”	-123° 05’ 19.83916”	253.542
LANE_31	43° 45’ 16.82389”	-122° 26’ 41.15314”	492.053
LANE_32	43° 47’ 33.82161”	-122° 25’ 40.76291”	677.205
LANE_29	43° 52’ 12.08177”	-122° 47’ 18.45224”	420.380
LANE_28	43° 53’ 58.92454”	-122° 48’ 59.17889”	194.478

Lane County GPS Monuments			
PID	Latitude	Longitude	Ellipsoid Height (m)
LANE_34	43° 45' 30.54400"	-122° 29' 48.47559"	308.081
LANE_29A	43° 52' 12.08161"	-122° 47' 18.45256"	420.361
AI2001	43° 55' 19.20493"	-122° 47' 41.08223"	195.963
LANE_35	43° 48' 11.57911"	-122° 42' 37.56859"	1041.596
LANE_36	43° 50' 54.28025"	-123° 21' 47.73924"	229.292
LANE_37	43° 51' 23.46541"	-123° 25' 02.19196"	197.776
LANE_20	43° 53' 27.38516"	-123° 28' 30.83622"	153.934
LANE_18	43° 55' 40.86962"	-123° 37' 20.35729"	178.186
LANE_38	43° 58' 54.14928"	-123° 41' 53.55130"	424.298
LANE_10	44° 00' 11.70302"	-123° 59' 45.31927"	-21.486
LANE_46	43° 38' 28.84405"	-123° 12' 52.40829"	104.565
LANE_47	43° 35' 46.97747"	-123° 15' 08.04840"	105.980
LANE_33	43° 36' 30.58173"	-123° 01' 40.84386"	471.540
RP_265+4988	43° 25' 06.36155"	-123° 09' 01.37675"	201.245
LANE_43	43° 21' 17.49608"	-122° 44' 41.88280"	524.594
LANE_39	43° 42' 19.93987"	-122° 57' 05.04012"	456.450
LANE_40	43° 35' 23.35579"	-123° 00' 04.90380"	479.127
LANE_41	43° 44' 45.10607"	-122° 53' 27.75969"	236.302
LANE_42	43° 40' 03.45665"	-122° 48' 42.76721"	311.004
LANE_49	43° 41' 54.47511"	-122° 46' 16.97790"	331.018
LANE_45	43° 30' 26.64379"	-122° 50' 42.75367"	1160.885
LANE_06	44° 12' 10.80764"	-123° 30' 31.42667"	196.522
LANE_12	44° 05' 44.71178"	-123° 43' 49.91180"	63.439
LANE_06A	44° 14' 32.55999"	-123° 24' 47.48386"	336.456
LANE_03	44° 17' 35.16542"	-123° 41' 42.13047"	69.602
LANE_51	44° 05' 39.63958"	-122° 47' 04.98635"	545.973

Lane County GPS Monuments			
PID	Latitude	Longitude	Ellipsoid Height (m)
AI1987	44° 12’ 27.42931”	-122° 49’ 49.03656”	157.321
LANE_04	44° 19’ 30.86443”	-123° 39’ 58.03953”	230.843
LANE_53	44° 11’ 00.46734”	-121° 55’ 12.33453”	1466.849
LANE_54	44° 10’ 41.98041”	-121° 57’ 40.08010”	1208.453
LANE_55	44° 14’ 58.44023”	-121° 49’ 52.63978”	1558.758
LANE_56	44° 15’ 38.38604”	-121° 48’ 09.68817”	1601.779
AJ8191	44° 39’ 23.18028”	-121° 41’ 33.57573”	1983.063
LANE_59	44° 42’ 09.70199”	-122° 04’ 57.99867”	497.773
LANE_69	44° 42’ 36.07455”	-122° 06’ 34.98373”	463.920
WRM_SP_01	44° 39’ 22.75371”	-121° 41’ 33.13407”	1981.876
LANE_57	44° 25’ 19.90234”	-121° 51’ 23.67546”	1434.237
LANE_58	44° 26’ 11.01683”	-121° 56’ 36.51882”	1117.648
LANE_63	44° 15’ 13.30087”	-122° 07’ 55.02809”	1377.917
LANE_64	44° 13’ 05.95603”	-122° 06’ 13.58282”	1482.944
LANE_67	44° 09’ 58.41010”	-122° 40’ 34.96786”	736.802
LANE_68	44° 12’ 06.66895”	-122° 39’ 43.82798”	699.408
LANE_60	44° 40’ 38.57139”	-121° 54’ 04.98722”	1281.918
LANE_70	44° 07’ 45.63642”	-122° 26’ 24.72517”	543.955
BLUE_RIV_04	44° 19’ 45.50913”	-122° 06’ 01.51323”	1412.718
LANE_71	44° 10’ 24.58901”	-122° 32’ 25.77843”	536.990
LANE_74	44° 04’ 58.19343”	-122° 21’ 53.66019”	715.086

Appendix C : Selected Imagery

Orthophotos: **Top Left:** Main Street Bridge, Springfield, Oregon. **Top Right:** McKenzie View Drive, south of Coburg, Oregon. **Bottom Left:** Kellogg Road, Springfield, Oregon **Bottom Right:** Island Park along the Willamette River, Spring-field, Oregon.



Highest Hit DEM of section of Delivery Area Two.

LiDAR derived DEM’s: **Above** highest hit DEM and **Below:** bare earth DEM. Both areas depicted are within delivery area three.