GROUND CONTROL SURVEY REPORT MOUNT BIDWELL - MODOC

GPS SURVEY FOR LIDAR CONTROL

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1. ABSTRACT

This report documents the GPS ground surveys conducted in support of LIDAR data collection for the Mount Bidwell-Modoc area. The surveyed ground control was established on October 5 ,2013 . The aerial collection was performed with the Optech ALTM Gemini LiDAR. The ground control stations were established utilizing the **Leica RX1205 XC** Survey receiver. There were no problems encountered during this survey. The ground survey was conducted at 9 sites utilizing the CORS stations identified on the ***OPUS*** Data sheets. These surveys established "Ground Truth" data at each site.

A Beechcraft Bonanza A36TC, based out of Chino Airport, CA was utilized on this project for the LiDAR Mission. This aircraft was outfitted with an Optech Gemini ALTM 167kHZ system (s/n 07SEN204).

Mission planning parameters for the LiDAR noted below. These lines would be flown using the following settings:

Altitude:	**800 m**
Overlap:	**60 %**
Speed:	**120 kts**
System PRF:	**70 kHz**
Scan Freq:	**64 Hz**
Scan Half Angle:	**10°**
Cross Track Res.:	**0.491 m**
Down Track Res.:	**0.482 m**

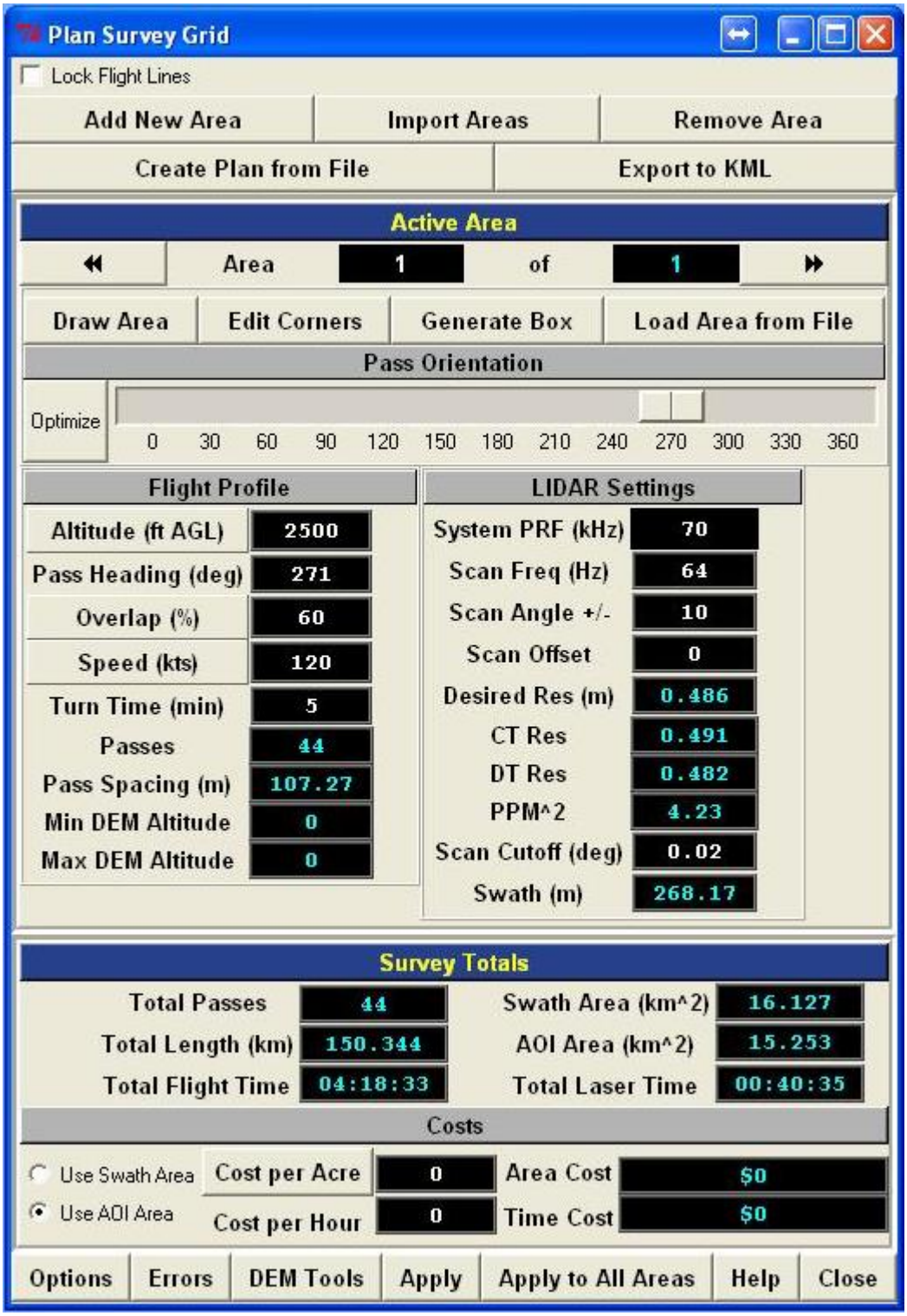
The actual local flight times and duration of flights were controlled by fuel consumption of the aircraft, safety of flight operations in the particular airspace and during times when the GPS constellation was most favorable, producing the highest number of satellites visible in the best geometric configuration relative to the GPS receivers onboard the aircraft as well as at the master stations on the ground. A standard of flying with no less than 6 satellites visible and a PDOP (position dilution of precision) of less than 3.0 was adopted.

Statistical comparisons were made between ground truth points collected in the survey and airborne LIDAR points .

Comparisons were also made between the survey points and the LIDAR derived terrain surface. These comparisons provide an additional verification of the LIDAR data against the survey data.

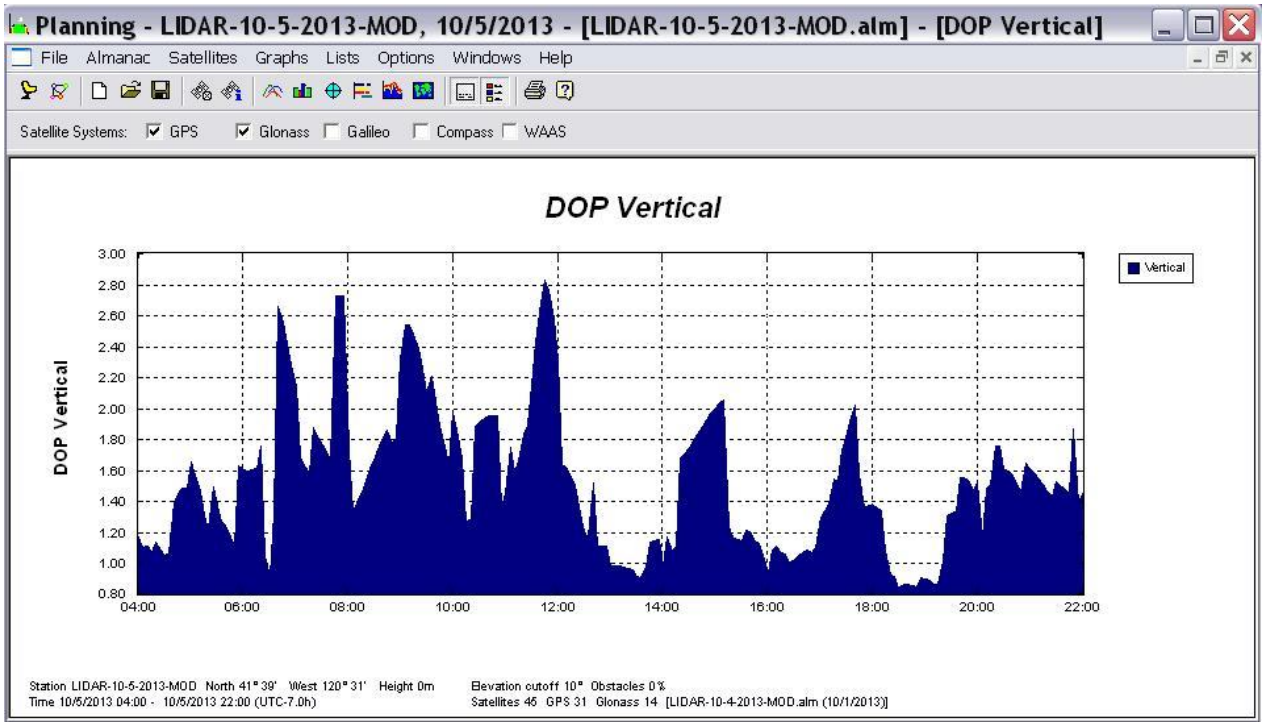
The horizontal and vertical datum used for this project are listed below:

Vertical Datum:	**NAVD88, Geoid12A**
Horizontal Datum:	**NAD83**
Projection:	**UTM Zone 10**
Units:	**METERS**

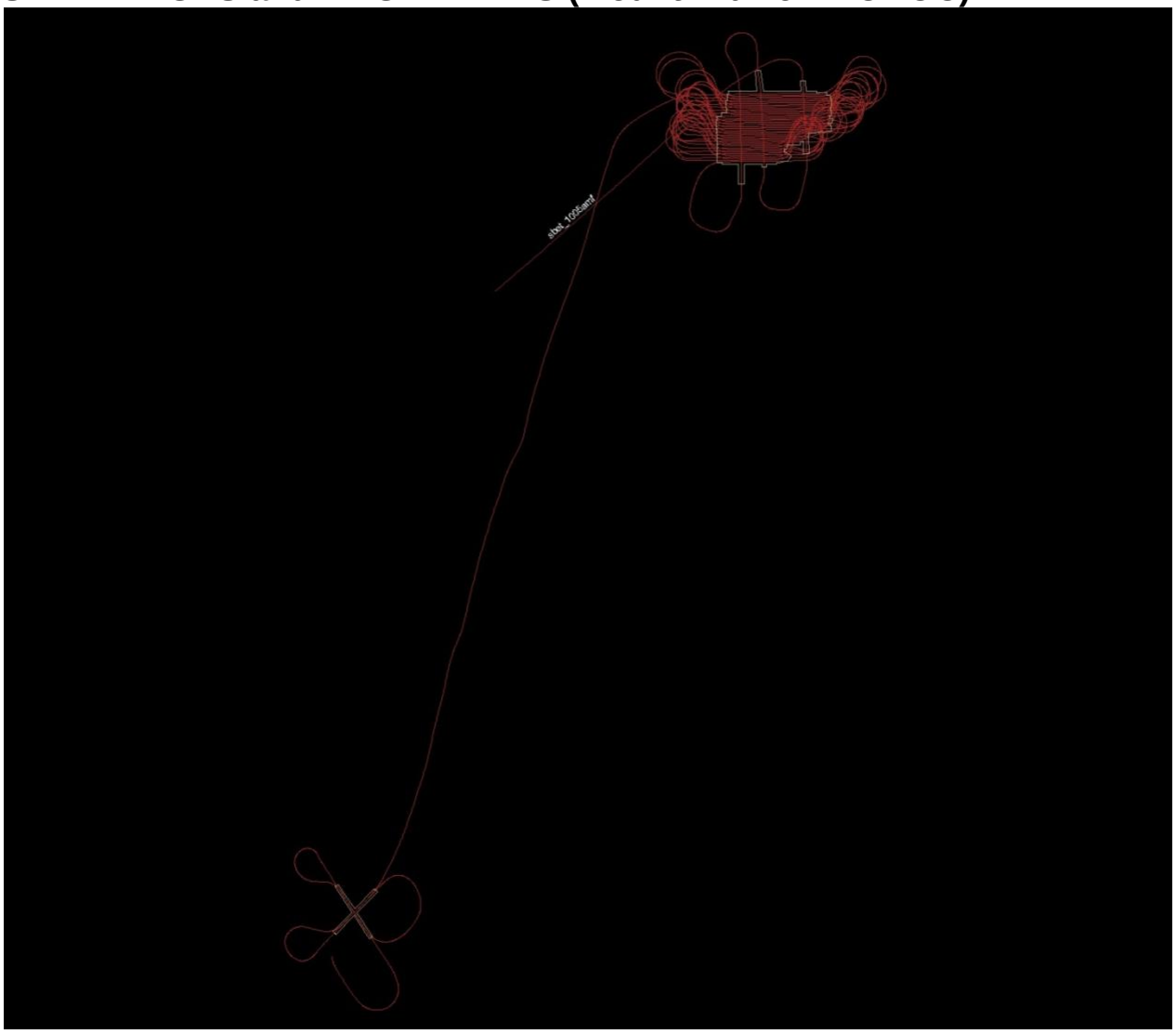


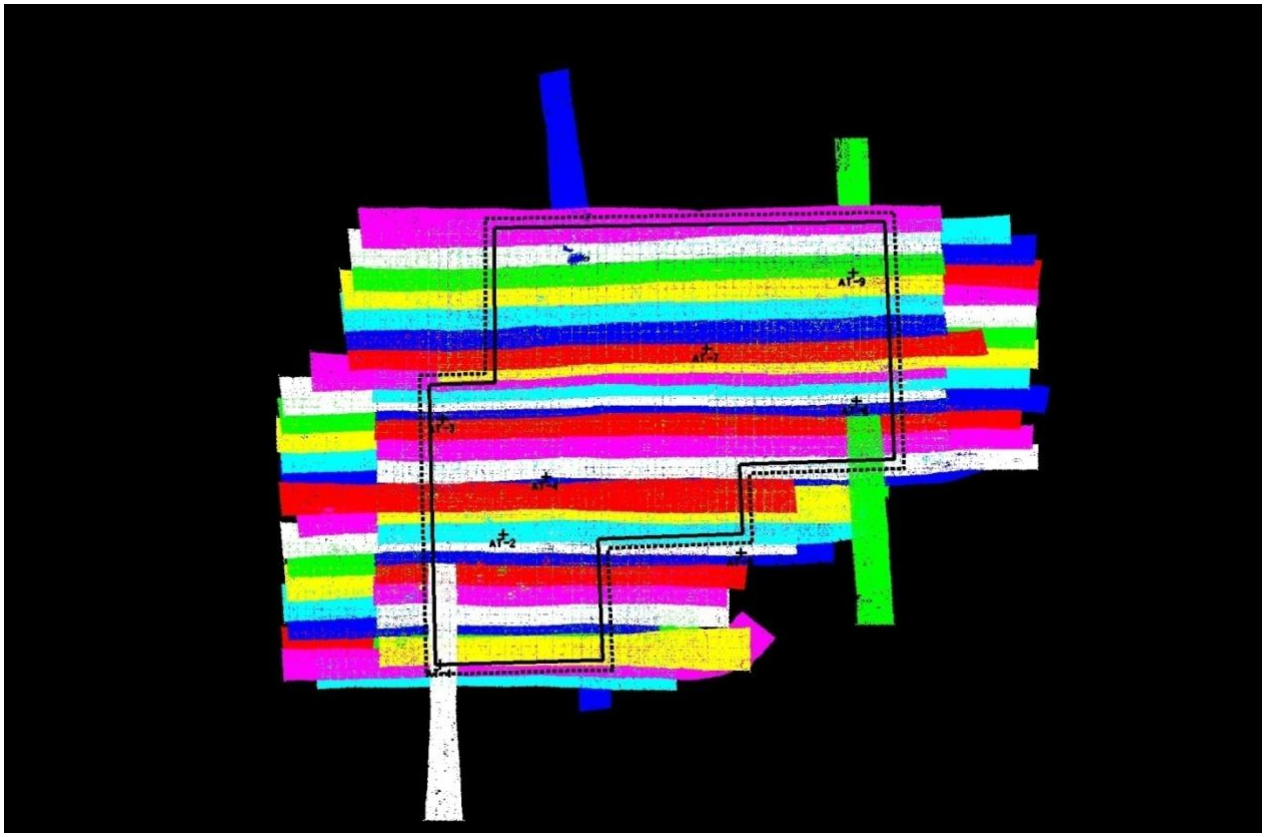
LiDAR MISSION PARAMETERS

DMI always checked PDOP before commencing flight (weather permitting) shows data collection and dates with PDOP report October 5 (MOUNT MIDWELL-MODOC)



SBET IMAGES and FLIGHT LINES (Mount Bidwell-MODOC)





OPUS: Online Positioning User Service – Solution Report
@ ½ Second

Ground Receiver UNIT 1 - 10/05/2013

START: 2013/10/05 13:22:00
STOP: 2013/10/05 18:22:00

ANT NAME: LEIAX1202 NONE # FIXED AMB: 73 / 77 : 95%

ARP HEIGHT: 1.6508 OVERALL RMS: 0.016(m)

REF FRAME:	NAD_83(2011)(EPOCH:2010.0000)		IGS08 (EPOCH:2013.7607)	
X:	-2395586.760(m)	0.024(m)	-2395587.618(m)	0.024(m)
Y:	-4100454.715(m)	0.018(m)	-4100453.463(m)	0.018(m)
Z:	4245625.335(m)	0.012(m)	4245625.321(m)	0.012(m)
LAT:	41 59 18.12665	0.012(m)	41 59 18.14036	0.012(m)
E LON:	239 42 19.70694	0.011(m)	239 42 19.64733	0.011(m)
W LON:	120 17 40.29306	0.011(m)	120 17 40.35267	0.011(m)
EL HGT:	1467.443(m)	0.027(m)	1466.952(m)	0.027(m)
ORTHO HGT:	1488.481(m)	0.050(m)	[NAVD88 (Computed using GEOID12A)]	

UTM COORDINATES STATE PLANE COORDINATES

	UTM (Zone 10)	SPC (0401 CA 1)
Northing (Y) [meters]	4652025.887	796206.673
Easting (X) [meters]	724110.617	2141330.438
Convergence [degrees]	1.81065906	1.11518278
Point Scale	1.00021807	1.00009765
Combined Factor	0.99998792	0.99986752

US NATIONAL GRID DESIGNATOR: 10TGM2411052025(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DH3761	MDMT MEDICINE MOUNTAIN CORS ARP	N422506.013	W1211317.707	90258.8
DK6484	MODB MODOC PLATEAU CORS ARP	N415408.355	W1201810.137	9585.0
DN7467	P731 LILJUNIPERCN2007 CORS ARP	N411957.039	W1202821.887	74357.3
	NEAREST NGS PUBLISHED CONTROL POINT			
MW0735	FAIRPORT	N415935.676	W1201844.359	1569.3

Ground Receiver UNIT 2 - 10/05/2013

START: 2013/10/05 13:32:00
STOP: 2013/10/05 18:25:00

ANT NAME: LEIAX1202 NONE # FIXED AMB: 52 / 53 : 98%

ARP HEIGHT: 1.6248 OVERALL RMS: 0.012(m)

REF FRAME:	NAD_83(2011)(EPOCH:2010.0000)		IGS08 (EPOCH:2013.7607)	
X:	-2395666.453(m)	0.007(m)	-2395667.311(m)	0.007(m)
Y:	-4100607.810(m)	0.010(m)	-4100606.558(m)	0.010(m)
Z:	4245436.303(m)	0.011(m)	4245436.289(m)	0.011(m)
LAT:	41 59 9.83686	0.003(m)	41 59 9.85057	0.003(m)
E LON:	239 42 20.07253	0.006(m)	239 42 20.01293	0.006(m)
W LON:	120 17 39.92747	0.006(m)	120 17 39.98707	0.006(m)
EL HGT:	1469.124(m)	0.015(m)	1468.633(m)	0.015(m)
ORTHO HGT:	1490.163(m)	0.034(m)	[NAVD88 (Computed using GEOID12A)]	

UTM COORDINATES STATE PLANE COORDINATES

	UTM (Zone 10)	SPC (0401 CA 1)
Northing (Y) [meters]	4651770.455	795951.090
Easting (X) [meters]	724127.114	2141343.831
Convergence [degrees]	1.81064628	1.11524918
Point Scale	1.00021816	1.00009684
Combined Factor	0.99998774	0.99986645

US NATIONAL GRID DESIGNATOR: 10TGM2412751770(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DN7398	P348 HATCHETMTNCN2005 CORS ARP	N405419.951	W1214940.756	51530.6
DN7515	P060 POLLARDFLTCN2005 CORS ARP	N405951.462	W1222453.528	55276.0
DN7461	P674 GLASSMTN__CN2006 CORS ARP	N413658.746	W1212923.893	48693.3

NEAREST NGS PUBLISHED CONTROL POINT

MW0387	K 499	N412114.	W1215731.	542.3

2. GROUND TRUTH SUMMARY

Surveys were conducted to establish ground truth data at representative sites throughout the project area. These sites were selected on the basis of the optimizing visibility needed for the LIDAR survey over the area.

MOUNT BIDWELL-MODOC 2013 / DIGITAL MAPPING INC./ UTM 10

AERIAL POINT#	LATITUDE	LONGITUDE	NORTH (M)	EAST (M)	TARGET ELEV.	DESCRIPTION
AT 1	41°56'21.44453" N	120°13'43.21612" W	4646750.690	729742.600	2420.023	SET 60D SPIKE
AT 2	41°57'04.23315" N	120°13'12.84214" W	4648093.169	730399.269	2312.060	SET 60D SPIKE
AT 3	41°57'43.57546" N	120°13'38.55399" W	4649287.491	729767.952	2125.229	SET 60D SPIKE
AT 4	41°57'22.96457" N	120°12'52.67180" W	4648686.030	730844.907	2429.415	SET 60D SPIKE
AT 5	41°56'55.35538" N	120°11'26.33428" W	4647899.358	732860.640	1912.663	SET 60D SPIKE
AT 6	41°57'44.85320" N	120°10'32.22025" W	4649467.109	734056.332	2202.155	SET 60D SPIKE
AT 7	41°58'04.13171" N	120°11'38.68186" W	4650011.450	732506.804	2322.718	SET 60D SPIKE
AT 9	41°58'27.99261" N	120°10'31.92297" W	4650797.978	734019.275	2408.814	SET 60D SPIKE

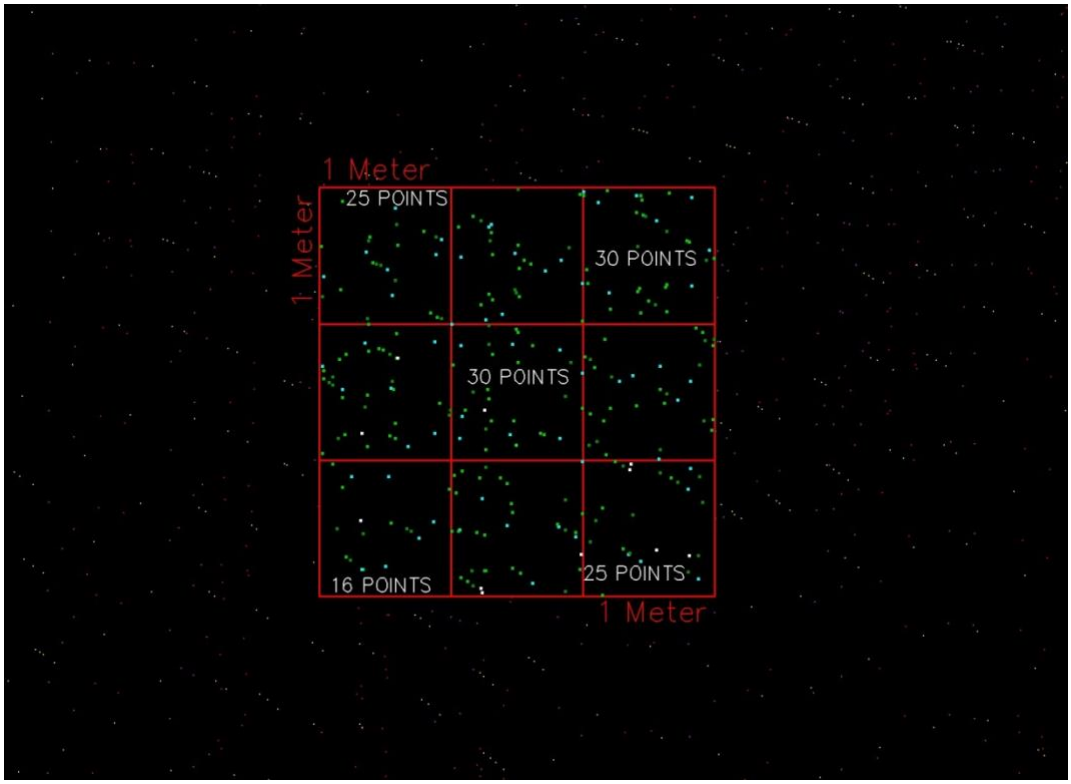
CORS SITES USED (PLEASE REFER TO OPUS DATA SHEETS)

3. DATA ANALYSIS

Data analysis was accomplished by comparing ground truth checkpoints with LIDAR points from the edited data set. The only exception to this were the ground truth points collected under the tree/forest canopy, where comparisons were made with LIDAR pulses that fell near known positions. This is because fewer LIDAR pulses are able to reach the ground in heavily forested areas, so the point spacing is larger than in cleared areas.

The base stations used to collect survey data were included in the static GPS network, and were selected on the basis of their having an unobstructed view of the sky, as well as being in a location considered favorable for collecting ground truth data. The vertical and horizontal accuracy of each base station was determined by the statistical tests performed in the least squares adjustment process.

Note that the edited LIDAR points are simply a subset of the raw LIDAR points. The points that fell above the ground surface on vegetation canopies, buildings, or other obstructions were removed from the data set. Comparisons were also made between the survey points and the LIDAR derived terrain surface. These comparisons provide an additional verification of the LIDAR data against the survey data.



ONE METER SQUARE

LiDAR POINT CHECK

Our ground control check from QA/QC supported in attached documents

4. GROUND TRUTH SURVEY

A. Map of Control Point Locations/ Base Station

B. Ground Truth Analysis of LIDAR Points

GROUND TRUTH ANALYSIS

Comparison of LIDAR Points to Ground Truth Points

GeoCue software was used to compare known , position established and occupied for twenty-minutes , control points versus identical position of LiDAR XYZ point data. The intensity image produced from the *LIDAR collection, was used to pick areas where ground and truth data collection could be collected. In areas of flat terrain or areas where detail is important it can be used as areas to collect X,Y,Z ground truth data for accessing the accuracy of the LIDAR data. Ground truth data can be collected using conventional survey techniques or DGPS techniques.*

SPATIAL REFERENCE FRAMEWORK

Vertical Datum **NAVD88, Geoid12A**
Horizontal Datum **NAD83**
Projection **UTM Zone 10**
Units **METERS**

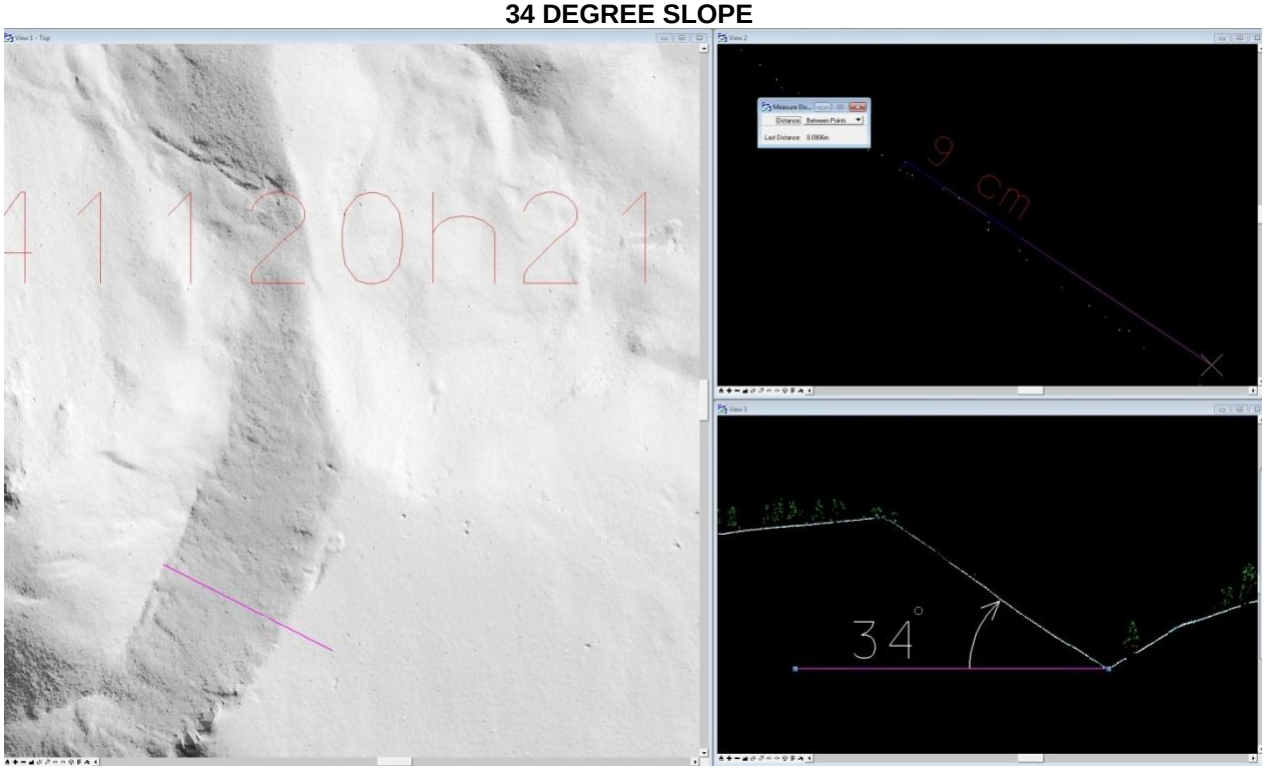
Ground Control Z vs. Aerial Surveyed/ Laser Pointing Z (QA/QC)

MOUNT BIDWELL-MODOC

Number	Easting	Northing	Known Z	Laser Z	Dz
AT-1	729742.600	4646750.690	2420.023	2420.030	+0.007
AT-2	730399.269	4648093.169	2312.060	2312.060	+0.000
AT-3	729767.952	4649287.491	2125.229	2125.280	+0.051
AT-4	730844.907	4648686.030	2429.415	2429.340	-0.075
AT-5	732860.640	4647899.358	1912.663	1912.590	-0.073
AT-6	734056.332	4649467.109	2202.155	2202.180	+0.025
AT-7	732506.804	4650011.450	2322.718	2322.680	-0.038
AT-9	734019.275	4650797.978	2408.814	2408.910	+0.096

Average dz	-0.001
Minimum dz	-0.075
Maximum dz	+0.096
Average magnitude	0.046
Root mean square	0.056
Std deviation	0.060

34 DEGREE SLOPE



16 DEGREE SLOPE