

GROUND CONTROL SURVEY REPORT MEDICINE LAKE - Harris and Medicine Lake Volcano

GPS SURVEY FOR LIDAR CONTROL

CONTENTS

1. ABSTRACT	2
2. GROUND TRUTH SUMMARY	24
3. DATA ANALYSIS	25
4. GROUND TRUTH SURVEY	26
A. Map of Ground Truth Locations	
B. Ground Truth Analysis of LIDAR Points	

1. ABSTRACT

This report documents the GPS ground surveys conducted in support of LIDAR data collection for the Modoc Forest area. The surveyed ground control was established on October 6-7-8 and 16-17-18 (Medicine Lake and Harris), 2013 . The aerial collection was performed with the Optech ALTM Gemini LiDAR Sensor on October 6, 7, 8, 16, 17, and 18 (Medicine Lake and Harris), 2013 . 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 24 (Medicine Lake and Harris) 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

76 Plan Survey Grid

☐ Lock Flight Lines

Active Area

Area **1** of **3**

Pass Orientation

0 30 60 90 120 150 180 210 240 270 300 330 360

Flight Profile		LIDAR Settings	
Altitude (ft AGL)	2500	System PRF (kHz)	70
Pass Heading (deg)	90	Scan Freq (Hz)	64
Overlap (%)	60	Scan Angle +/-	10
Speed (kts)	120	Scan Offset	0
Turn Time (min)	5	Desired Res (m)	0.486
Passes	141	CT Res	0.491
Pass Spacing (m)	107.27	DT Res	0.482
Min DEM Altitude	4573	PPM^2	4.23
Max DEM Altitude	7897	Scan Cutoff (deg)	0.02
		Swath (m)	268.17

Survey Totals

Total Passes	272	Swath Area (km^2)	380.017
Total Length (km)	3542.616	AOI Area (km^2)	365.444
Total Flight Time	38:59:46	Total Laser Time	15:56:26

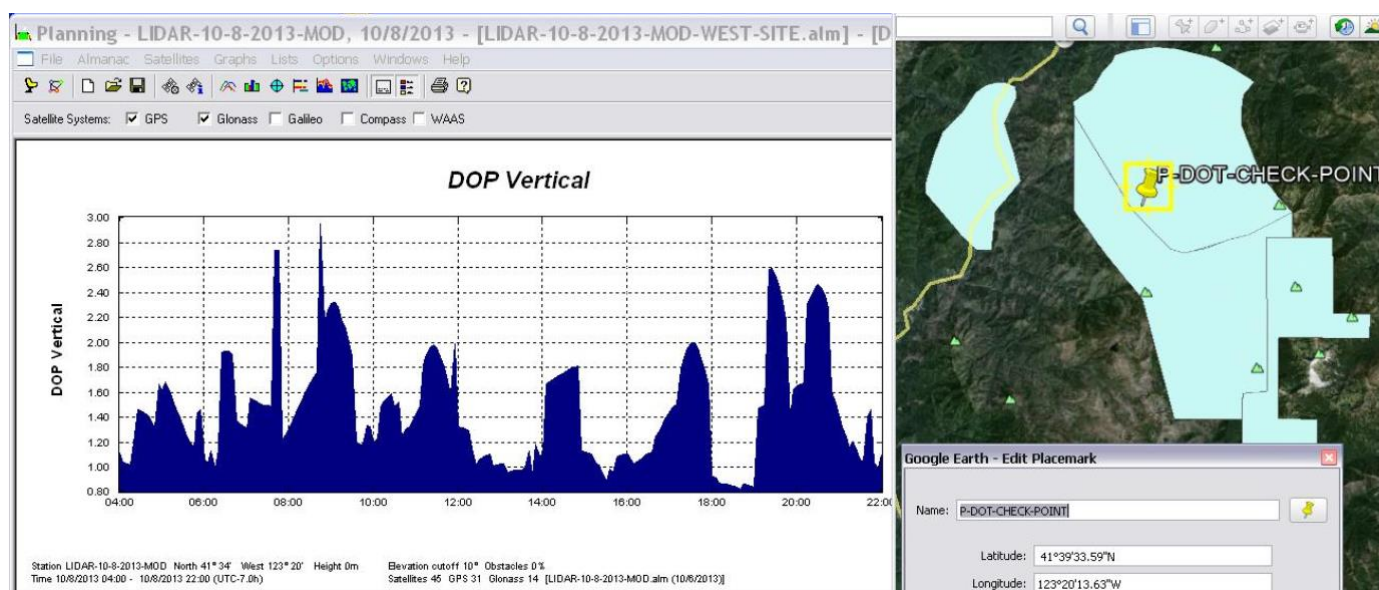
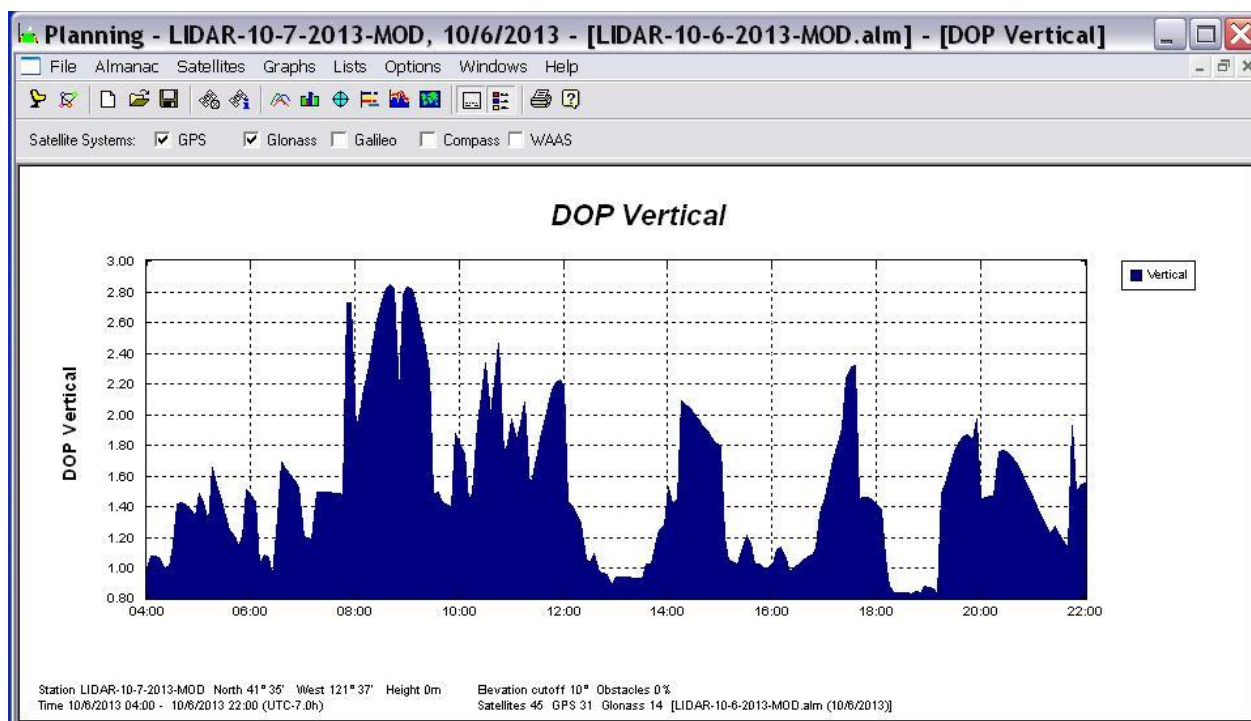
Costs

☐ Use Swath Area
 Cost per Acre **0**
Area Cost **\$0**

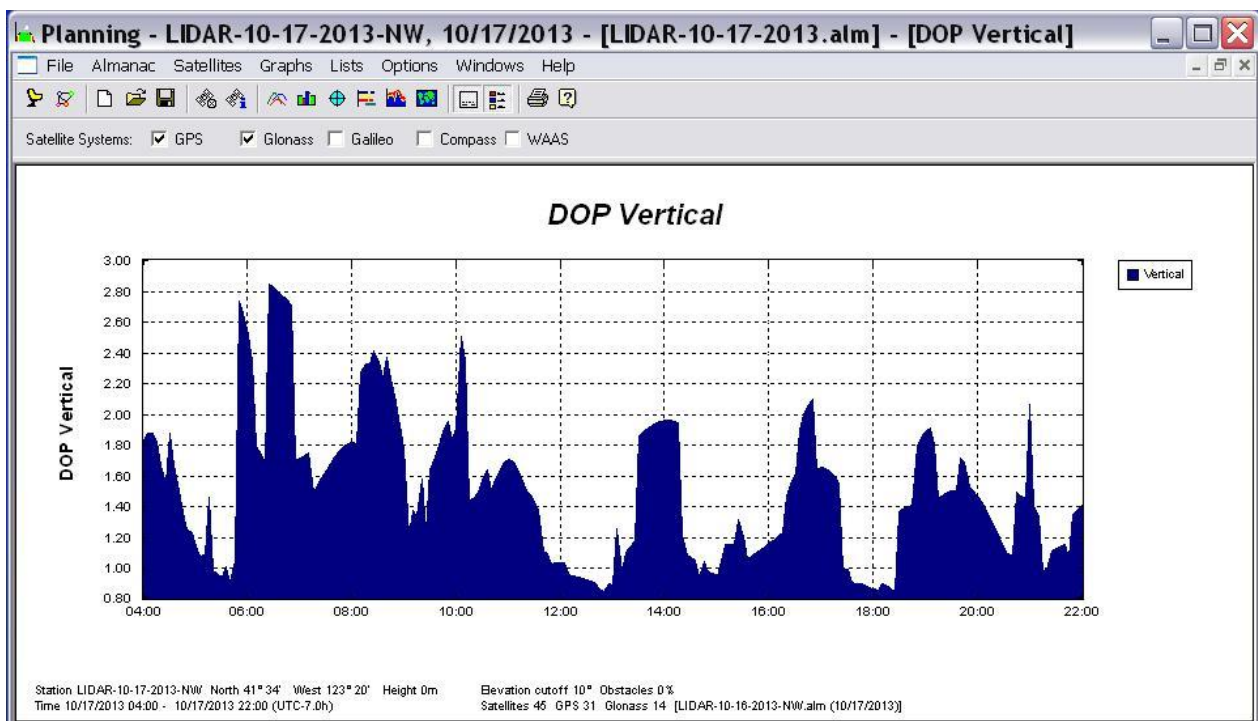
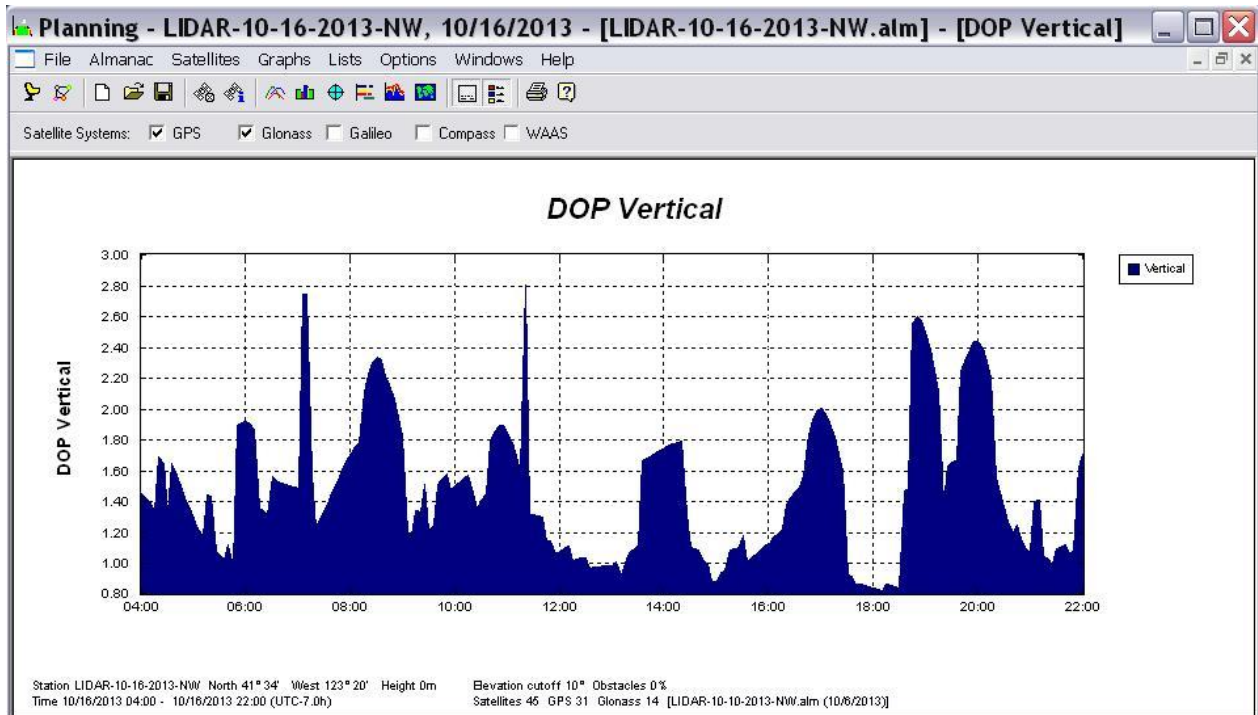
☒ Use AOI Area
 Cost per Hour **0**
Time Cost **\$0**

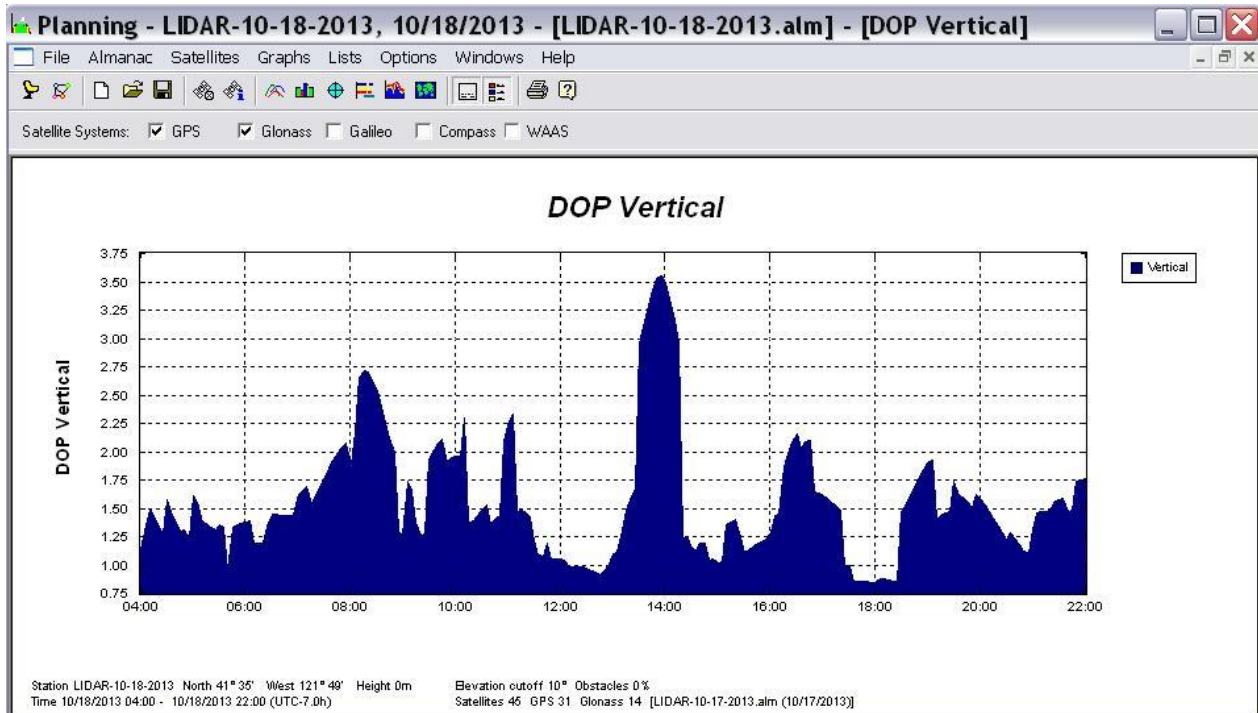
LiDAR MISSION PARAMETERS

DMI always checked PDOP before commencing flight (weather permitting) – next page shows data collection and dates with PDOP report September 7 and 8 (TROUT) and October 6, 7, 8, 16, 17, and 18 (Medicine Lake and Harris)

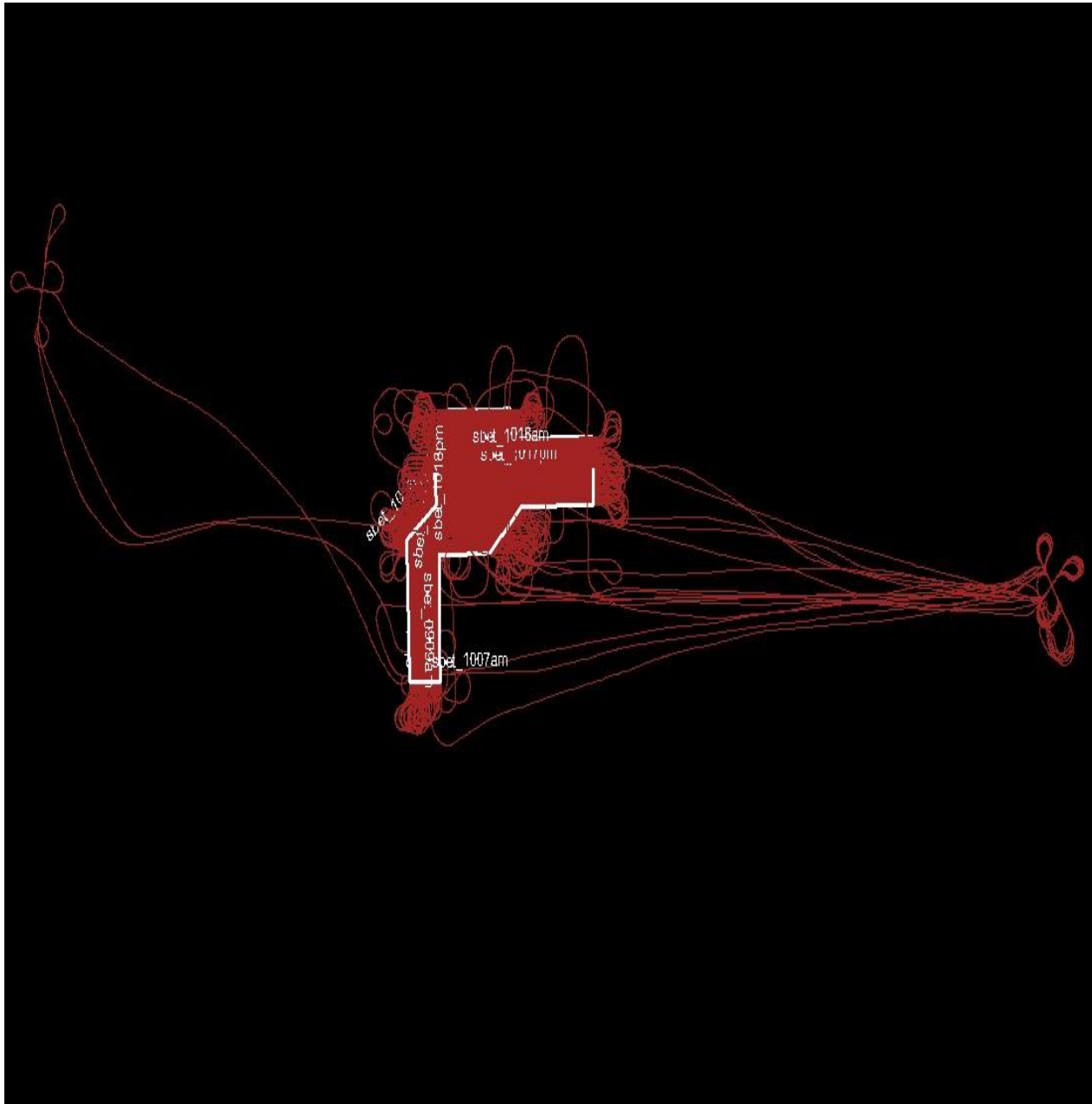


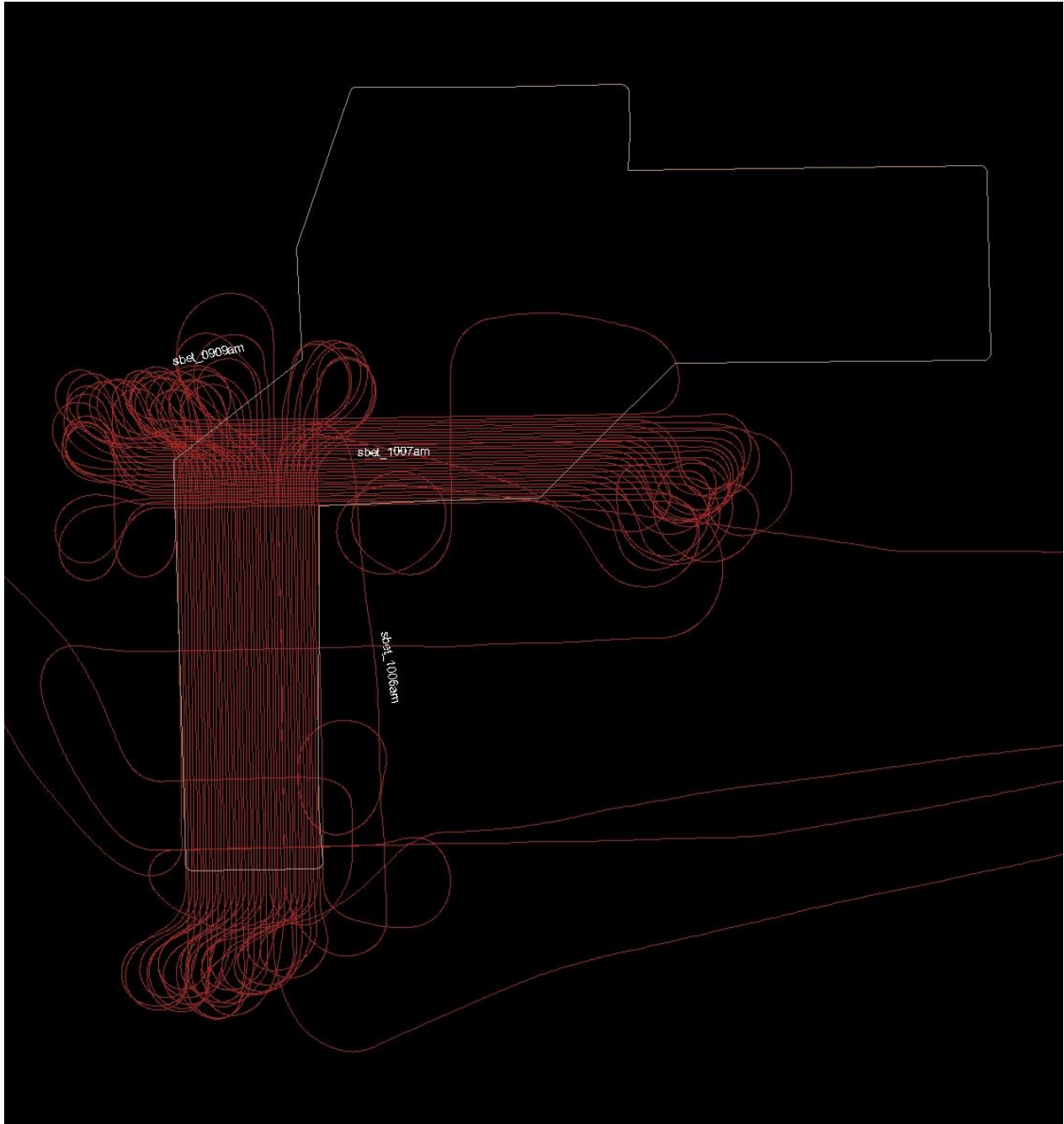
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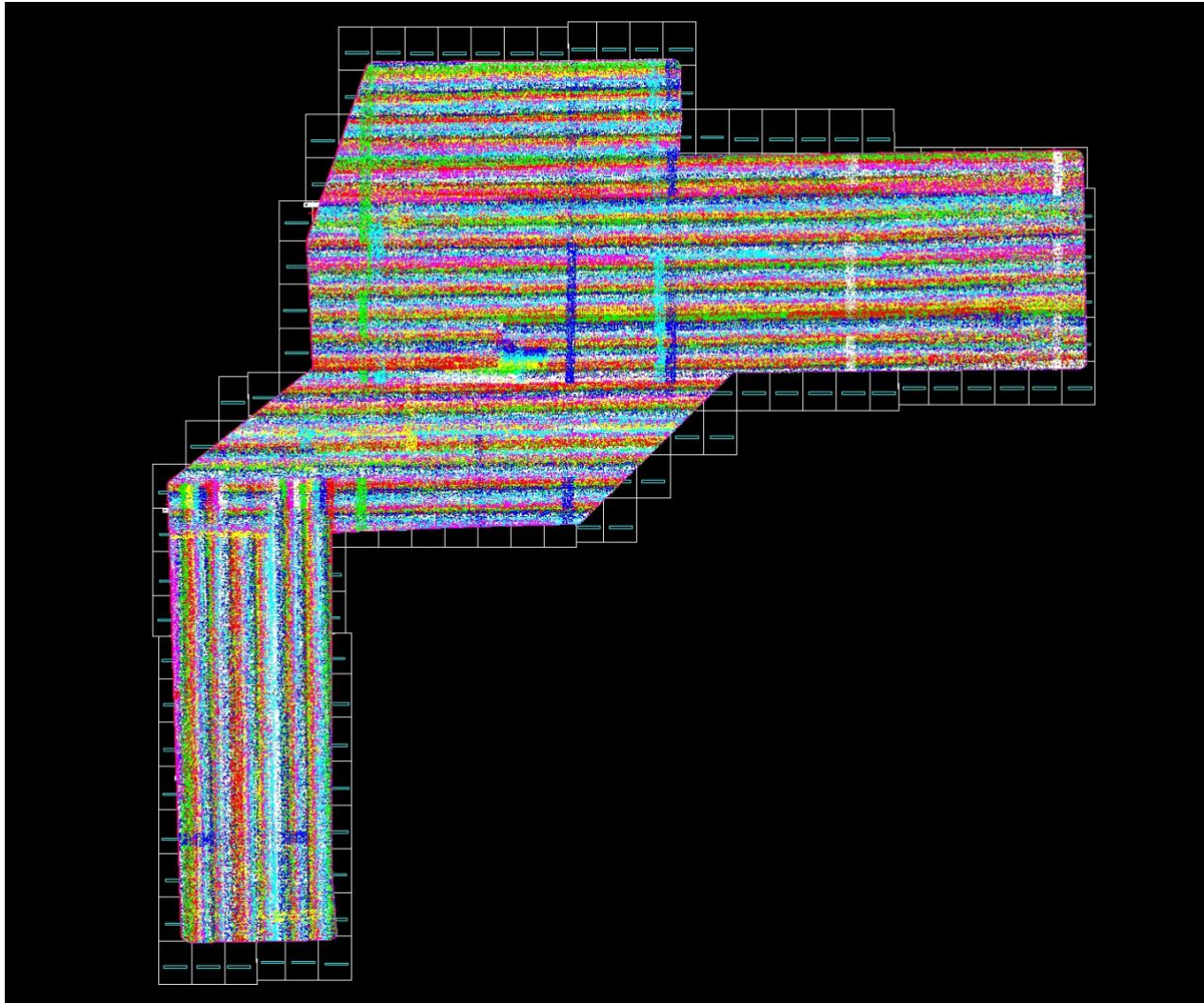


SBET IMAGES and FLIGHT LINES









OPUS: Online Positioning User Service – Solution Report **@ 1/2 Second**

Ground Receiver UNIT 1 - 10/06/2013

START: 2013/10/06 14:13:00
STOP: 2013/10/06 20:35:00

ANT NAME: LEIAX1202 NONE # FIXED AMB: 72 / 80 : 90%

ARP HEIGHT: 1.6448 OVERALL RMS: 0.011(m)

REF FRAME: NAD_83(2011) (EPOCH:2010.0000) IGS08 (EPOCH:2013.7636)

X:	-2513602.648(m)	0.009(m)	-2513603.505(m)	0.009(m)
Y:	-4069801.347(m)	0.008(m)	-4069800.094(m)	0.008(m)
Z:	4207300.661(m)	0.009(m)	4207300.653(m)	0.009(m)
LAT:	41 31 27.06936	0.001(m)	41 31 27.08239	0.001(m)
E LON:	238 17 58.45524	0.006(m)	238 17 58.39541	0.006(m)
W LON:	121 42 1.54476	0.006(m)	121 42 1.60459	0.006(m)
EL HGT:	1684.849(m)	0.013(m)	1684.382(m)	0.013(m)
ORTHO HGT:	1707.968(m)	0.032(m)	[NAVD88 (Computed using GEOID12A)]	

UTM COORDINATES STATE PLANE COORDINATES

	<u>UTM (Zone 10)</u>	<u>SPC (0401 CA 1)</u>
Northing (Y) [meters]	4597764.587	743316.502
Easting (X) [meters]	608426.566	2025002.838
Convergence [degrees]	0.86161628	0.19588471
Point Scale	0.99974468	0.99996693
Combined Factor	0.99948055	0.99970274

US NATIONAL GRID DESIGNATOR: 10TFL0842697764(NAD 83)

BASE STATIONS USED

<u>PID</u>	<u>DESIGNATION</u>	<u>LATITUDE</u>	<u>LONGITUDE</u>	<u>DISTANCE(m)</u>
DN7461 P674 GLASSMTN__CN2006	CORS ARP	N413658.746	W1212923.893	20325.1
DN7398 P348 HATCHETMTNCN2005	CORS ARP	N405419.951	W1214940.756	69551.1
DN7470 P784 YORKMN040GCN2008	CORS ARP	N414950.922	W1222513.585	68969.6
NEAREST NGS PUBLISHED CONTROL POINT				
MW0916	TWIN CRATER MTN	N413021.183	W1214426.981	3935.8

Ground Receiver UNIT 2 - 10/06/2013

START: 2013/10/06 14:20:00

STOP: 2013/10/06 20:32:00

ANT NAME: LEIAX1202 NONE # FIXED AMB: 67 / 68 : 99%

ARP HEIGHT: 1.6448 OVERALL RMS: 0.011(m)

REF FRAME: NAD_83(2011)(EPOCH:2010.0000)

IGS08 (EPOCH:2013.7636)

X:	-2513488.232(m)	0.005(m)	-2513489.089(m)	0.005(m)
Y:	-4069691.508(m)	0.004(m)	-4069690.255(m)	0.004(m)
Z:	4207475.554(m)	0.008(m)	4207475.546(m)	0.008(m)

LAT:	41 31 34.61161	0.005(m)	41 31 34.62464	0.005(m)
E LON:	238 18 0.16407	0.003(m)	238 18 0.10424	0.003(m)
W LON:	121 41 59.83593	0.003(m)	121 41 59.89576	0.003(m)
EL HGT:	1685.818(m)	0.009(m)	1685.352(m)	0.009(m)
ORTHO HGT:	1708.928(m)	0.027(m)	[NAVD88 (Computed using GEOID12A)]	

UTM COORDINATES STATE PLANE COORDINATES

	UTM (Zone 10)	SPC (0401 CA 1)
Northing (Y) [meters]	4597997.784	743549.315
Easting (X) [meters]	608462.671	2025041.659
Convergence [degrees]	0.86196664	0.19619509
Point Scale	0.99974477	0.99996737
Combined Factor	0.99948049	0.99970303

US NATIONAL GRID DESIGNATOR: 10TFL0846297997(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DK6408 P347	ADINCTYARDCN2007 CORS ARP	N411100.021	W1205654.407	73539.8
DN7398 P348	HATCHETMTNCN2005 CORS ARP	N405419.951	W1214940.756	69787.2
DN7470 P784	YORKMN040GCN2008 CORS ARP	N414950.922	W1222513.585	68888.5

NEAREST NGS PUBLISHED CONTROL POINT

MW0916	TWIN CRATER MTN	N413021.183	W1214426.981	4094.2
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Ground Receiver UNIT 1 - 10/07/2013

START: 2013/10/07 12:36:00

STOP: 2013/10/07 19:25:00

ANT NAME: LEIAX1202 NONE # FIXED AMB: 69 / 70 : 99%

ARP HEIGHT: 1.5178 OVERALL RMS: 0.012(m)

REF FRAME: NAD_83(2011)(EPOCH:2010.0000) IGS08 (EPOCH:2013.7662)

X:	-2513602.659(m)	0.006(m)	-2513603.516(m)	0.006(m)
Y:	-4069801.355(m)	0.009(m)	-4069800.102(m)	0.009(m)
Z:	4207300.658(m)	0.009(m)	4207300.650(m)	0.009(m)

LAT:	41 31 27.06902	0.006(m)	41 31 27.08205	0.006(m)
E LON:	238 17 58.45502	0.003(m)	238 17 58.39519	0.003(m)
W LON:	121 42 1.54498	0.003(m)	121 42 1.60481	0.003(m)
EL HGT:	1684.856(m)	0.012(m)	1684.390(m)	0.012(m)

ORTHO HGT: 1707.975(m) 0.030(m) [NAVD88 (Computed using GEOID12A)]

UTM COORDINATES STATE PLANE COORDINATES

	UTM (Zone 10)	SPC (0401 CA 1)
Northing (Y) [meters]	4597764.576	743316.491
Easting (X) [meters]	608426.561	2025002.833
Convergence [degrees]	0.86161623	0.19588467
Point Scale	0.99974468	0.99996693
Combined Factor	0.99948055	0.99970274

US NATIONAL GRID DESIGNATOR: 10TFL0842697764(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DK6408 P347	ADINCTYARDCN2007 CORS ARP	N411100.021	W1205654.407	73454.4
DN7398 P348	HATCHETMTNCN2005 CORS ARP	N405419.951	W1214940.756	69551.1
DN7470 P784	YORKMN040GCN2008 CORS ARP	N414950.922	W1222513.585	68969.6

NEAREST NGS PUBLISHED CONTROL POINT

MW0916	TWIN CRATER MTN	N413021.183	W1214426.981	3935.8
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Ground Receiver UNIT 2 - 10/07/2013

START: 2013/10/07 12:43:00
STOP: 2013/10/07 19:28:00

ANT NAME: LEIAX1202 NONE # FIXED AMB: 97 / 98 : 99%

ARP HEIGHT: 1.5968 OVERALL RMS: 0.012(m)

REF FRAME: NAD_83(2011)(EPOCH:2010.0000) IGS08 (EPOCH:2013.7662)

X:	-2513488.232(m)	0.004(m)	-2513489.089(m)	0.004(m)
Y:	-4069691.501(m)	0.011(m)	-4069690.248(m)	0.011(m)
Z:	4207475.549(m)	0.013(m)	4207475.541(m)	0.013(m)
LAT:	41 31 34.61161	0.004(m)	41 31 34.62465	0.004(m)
E LON:	238 18 0.16391	0.005(m)	238 18 0.10408	0.005(m)
W LON:	121 41 59.83609	0.005(m)	121 41 59.89592	0.005(m)
EL HGT:	1685.810(m)	0.016(m)	1685.344(m)	0.016(m)
ORTHO HGT:	1708.920(m)	0.035(m)	[NAVD88 (Computed using GEOID12A)]	

	UTM COORDINATES	STATE PLANE COORDINATES
	UTM (Zone 10)	SPC (0401 CA 1)
Northing (Y) [meters]	4597997.784	743549.315
Easting (X) [meters]	608462.668	2025041.655
Convergence [degrees]	0.86196661	0.19619506
Point Scale	0.99974477	0.99996737
Combined Factor	0.99948049	0.99970303

US NATIONAL GRID DESIGNATOR: 10TFL0846297997(NAD 83)

BASE STATIONS USED						
PID	DESIGNATION		LATITUDE	LONGITUDE	DISTANCE(m)	
DN7398	P348	HATCHETMTNCN2005	CORS	ARP	N405419.951 W1214940.756	69787.2
DK6408	P347	ADINCTYARDCN2007	CORS	ARP	N411100.021 W1205654.407	73539.8
DN7470	P784	YORKMN040GCN2008	CORS	ARP	N414950.922 W1222513.585	68888.5

NEAREST NGS PUBLISHED CONTROL POINT			
MW0916	TWIN CRATER MTN	N413021.183 W1214426.981	4094.2

Ground Receiver UNIT 1 - 10/08/2013

START: 2013/10/08 12:35:00
STOP: 2013/10/08 18:01:00

ANT NAME: LEIAX1202 NONE # FIXED AMB: 71 / 73 : 97%

ARP HEIGHT: 1.7118 OVERALL RMS: 0.012(m)

REF FRAME: NAD_83(2011)(EPOCH:2010.0000) IGS08 (EPOCH:2013.7688)

X:	-2506945.001(m)	0.008(m)	-2506945.858(m)	0.008(m)
Y:	-4074635.041(m)	0.005(m)	-4074633.788(m)	0.005(m)
Z:	4206710.585(m)	0.003(m)	4206710.576(m)	0.003(m)
LAT:	41 30 59.41042	0.002(m)	41 30 59.42348	0.002(m)
E LON:	238 23 52.18560	0.009(m)	238 23 52.12582	0.009(m)
W LON:	121 36 7.81440	0.009(m)	121 36 7.87418	0.009(m)
EL HGT:	1758.748(m)	0.002(m)	1758.279(m)	0.002(m)
ORTHO HGT:	1781.757(m)	0.022(m)	[NAVD88 (Computed using GEOID12A)]	

UTM COORDINATES STATE PLANE COORDINATES

	UTM (Zone 10)	SPC (0401 CA 1)
Northing (Y) [meters]	4597039.544	742495.866
Easting (X) [meters]	616638.513	2033207.525
Convergence [degrees]	0.92663548	0.26013436
Point Scale	0.99976742	0.99996533
Combined Factor	0.99949170	0.99968955

US NATIONAL GRID DESIGNATOR: 10TFL1663897039(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DN7464 P730	BALLARDRDGCN2007 CORS ARP	N412133.095	W1204941.645	67018.7
DN7398 P348	HATCHETMTNCN2005 CORS ARP	N405419.951	W1214940.756	70464.1
DK6408 P347	ADINCTYARDCN2007 CORS ARP	N411100.021	W1205654.407	66063.9

NEAREST NGS PUBLISHED CONTROL POINT				
MW0525	Z 502	N413122.	W1213258.	4449.8

Ground Receiver UNIT 2 - 10/08/2013

START: 2013/10/08 12:41:00
STOP: 2013/10/08 17:57:00

ANT NAME: LEIAX1202 NONE # FIXED AMB: 59 / 73 : 81%

ARP HEIGHT: 1.6928 OVERALL RMS: 0.013(m)

REF FRAME: NAD_83(2011)(EPOCH:2010.0000) IGS08 (EPOCH:2013.7688)

X:	-2506892.489(m)	0.022(m)	-2506893.346(m)	0.022(m)
Y:	-4074714.166(m)	0.009(m)	-4074712.912(m)	0.009(m)
Z:	4206664.030(m)	0.014(m)	4206664.021(m)	0.014(m)
LAT:	41 30 57.42435	0.011(m)	41 30 57.43743	0.011(m)
E LON:	238 23 55.90154	0.016(m)	238 23 55.84174	0.016(m)
W LON:	121 36 4.09846	0.016(m)	121 36 4.15826	0.016(m)
EL HGT:	1757.747(m)	0.019(m)	1757.277(m)	0.019(m)
ORTHO HGT:	1780.758(m)	0.039(m)	[NAVD88 (Computed using GEOID12A)]	

UTM COORDINATES STATE PLANE COORDINATES

	UTM (Zone 10)	SPC (0401 CA 1)
Northing (Y) [meters]	4596979.688	742434.988
Easting (X) [meters]	616725.636	2033293.964
Convergence [degrees]	0.92730981	0.26080930
Point Scale	0.99976767	0.99996521
Combined Factor	0.99949211	0.99968959

US NATIONAL GRID DESIGNATOR: 10TFL1672596979(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DK6408 P347	ADINCTYARDCN2007 CORS ARP	N411100.021	W1205654.407	65958.2
DN7461 P674	GLASSMTN__CN2006 CORS ARP	N413658.746	W1212923.893	14504.6
DN5668 P663	SHWHALEBAKCN2007 CORS ARP	N413154.969	W1220910.465	46104.6
NEAREST NGS PUBLISHED CONTROL POINT				
MW0525	Z 502	N413122.	W1213258.	4375.1

Ground Receiver UNIT 2 - 10/08/2013

START: 2013/10/08 12:41:00
STOP: 2013/10/08 17:57:00

ANT NAME: LEIAX1202 NONE # FIXED AMB: 59 / 73 : 81%

ARP HEIGHT: 1.6928 OVERALL RMS: 0.013(m)

REF FRAME: NAD_83(2011)(EPOCH:2010.0000) IGS08 (EPOCH:2013.7688)

X:	-2506892.489(m)	0.022(m)	-2506893.346(m)	0.022(m)
Y:	-4074714.166(m)	0.009(m)	-4074712.912(m)	0.009(m)
Z:	4206664.030(m)	0.014(m)	4206664.021(m)	0.014(m)
LAT:	41 30 57.42435	0.011(m)	41 30 57.43743	0.011(m)
E LON:	238 23 55.90154	0.016(m)	238 23 55.84174	0.016(m)
W LON:	121 36 4.09846	0.016(m)	121 36 4.15826	0.016(m)
EL HGT:	1757.747(m)	0.019(m)	1757.277(m)	0.019(m)
ORTHO HGT:	1780.758(m)	0.039(m)	[NAVD88 (Computed using GEOID12A)]	

UTM COORDINATES STATE PLANE COORDINATES

	UTM (Zone 10)	SPC (0401 CA 1)
Northing (Y) [meters]	4596979.688	742434.988
Easting (X) [meters]	616725.636	2033293.964
Convergence [degrees]	0.92730981	0.26080930
Point Scale	0.99976767	0.99996521
Combined Factor	0.99949211	0.99968959

US NATIONAL GRID DESIGNATOR: 10TFL1672596979(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DK6408 P347	ADINCTYARDCN2007 CORS ARP	N411100.021	W1205654.407	65958.2
DN7461 P674	GLASSMTN__CN2006 CORS ARP	N413658.746	W1212923.893	14504.6
DN5668 P663	SHWHALEBAKCN2007 CORS ARP	N413154.969	W1220910.465	46104.6
NEAREST NGS PUBLISHED CONTROL POINT				
MW0525	Z 502	N413122.	W1213258.	4375.1

Ground Receiver UNIT 1 - 10/16/2013

START: 2013/10/16 21:41:00
STOP: 2013/10/17 02:00:00

ANT NAME: LEIAX1202 NONE # FIXED AMB: 49 / 53 : 92%

ARP HEIGHT: 1.6478 OVERALL RMS: 0.012(m)

REF FRAME: NAD_83(2011)(EPOCH:2010.0000) IGS08 (EPOCH:2013.7918)

X:	-2506945.004(m)	0.010(m)	-2506945.861(m)	0.010(m)
Y:	-4074635.051(m)	0.004(m)	-4074633.797(m)	0.004(m)
Z:	4206710.590(m)	0.011(m)	4206710.581(m)	0.011(m)
LAT:	41 30 59.41032	0.006(m)	41 30 59.42340	0.006(m)
E LON:	238 23 52.18571	0.008(m)	238 23 52.12591	0.008(m)
W LON:	121 36 7.81429	0.008(m)	121 36 7.87409	0.008(m)
EL HGT:	1758.759(m)	0.013(m)	1758.289(m)	0.013(m)
ORTHO HGT:	1781.768(m)	0.031(m)	[NAVD88 (Computed using GEOID12A)]	

UTM COORDINATES STATE PLANE COORDINATES

	<u>UTM (Zone 10)</u>	<u>SPC (0401 CA 1)</u>
Northing (Y) [meters]	4597039.541	742495.863
Easting (X) [meters]	616638.515	2033207.528
Convergence [degrees]	0.92663550	0.26013438
Point Scale	0.99976742	0.99996533
Combined Factor	0.99949170	0.99968955

US NATIONAL GRID DESIGNATOR: 10TFL1663897039(NAD 83)

BASE STATIONS USED

<u>PID</u>	<u>DESIGNATION</u>	<u>LATITUDE</u>	<u>LONGITUDE</u>	<u>DISTANCE(m)</u>
DN7464 P730	BALLARDRDGCN2007 CORS ARP	N412133.095	W1204941.645	67018.7
DN7461 P674	GLASSMTN__CN2006 CORS ARP	N413658.746	W1212923.893	14512.9
DK6408 P347	ADINCTYARDCN2007 CORS ARP	N411100.021	W1205654.407	66063.9
NEAREST NGS PUBLISHED CONTROL POINT				
MW0525	Z 502	N413122.	W1213258.	4449.8

Ground Receiver UNIT 2 - 10/16/2013

START: 2013/10/16 21:46:00
STOP: 2013/10/17 02:03:00

ANT NAME: LEIAX1202 NONE # FIXED AMB: 39 / 40 : 98%

ARP HEIGHT: 1.5678 OVERALL RMS: 0.014(m)

REF FRAME: NAD_83(2011)(EPOCH:2010.0000) IGS08 (EPOCH:2013.7918)

X:	-2506892.492(m)	0.006(m)	-2506893.349(m)	0.006(m)
Y:	-4074714.167(m)	0.007(m)	-4074712.913(m)	0.007(m)
Z:	4206664.035(m)	0.006(m)	4206664.026(m)	0.006(m)
LAT:	41 30 57.42442	0.007(m)	41 30 57.43750	0.007(m)
E LON:	238 23 55.90145	0.006(m)	238 23 55.84165	0.006(m)
W LON:	121 36 4.09855	0.006(m)	121 36 4.15835	0.006(m)
EL HGT:	1757.752(m)	0.005(m)	1757.282(m)	0.005(m)
ORTHO HGT:	1780.763(m)	0.024(m)	[NAVD88 (Computed using GEOID12A)]	

UTM COORDINATES STATE PLANE COORDINATES

	UTM (Zone 10)	SPC (0401 CA 1)
Northing (Y) [meters]	4596979.690	742434.990
Easting (X) [meters]	616725.634	2033293.962
Convergence [degrees]	0.92730980	0.26080928
Point Scale	0.99976767	0.99996521
Combined Factor	0.99949211	0.99968959

US NATIONAL GRID DESIGNATOR: 10TFL1672596979(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DN7464	P730 BALLARDRDGCN2007 CORS ARP	N412133.095	W1204941.645	66919.7
DN7398	P348 HATCHETMTNCN2005 CORS ARP	N405419.951	W1214940.756	70428.4
DN7461	P674 GLASSMTN__CN2006 CORS ARP	N413658.746	W1212923.893	14504.6
NEAREST NGS PUBLISHED CONTROL POINT				
MW0525	Z 502	N413122.	W1213258.	4375.1

Ground Receiver UNIT 1 - 10/17/2013

START: 2013/10/17 12:54:00
STOP: 2013/10/17 17:00:00

ANT NAME: LEIAX1202 NONE # FIXED AMB: 131 / 139 : 94%

ARP HEIGHT: 1.6468 OVERALL RMS: 0.013(m)

REF FRAME: NAD_83(2011)(EPOCH:2010.0000) IGS08 (EPOCH:2013.7935)

X:	-2506945.005(m)	0.012(m)	-2506945.862(m)	0.012(m)
Y:	-4074635.053(m)	0.006(m)	-4074633.799(m)	0.006(m)
Z:	4206710.579(m)	0.006(m)	4206710.570(m)	0.006(m)
LAT:	41 30 59.41001	0.003(m)	41 30 59.42308	0.003(m)
E LON:	238 23 52.18572	0.007(m)	238 23 52.12592	0.007(m)
W LON:	121 36 7.81428	0.007(m)	121 36 7.87408	0.007(m)
EL HGT:	1758.753(m)	0.012(m)	1758.283(m)	0.012(m)
ORTHO HGT:	1781.762(m)	0.030(m)	[NAVD88 (Computed using GEOID12A)]	

UTM COORDINATES STATE PLANE COORDINATES

	<u>UTM (Zone 10)</u>	<u>SPC (0401 CA 1)</u>
Northing (Y) [meters]	4597039.531	742495.853
Easting (X) [meters]	616638.516	2033207.528
Convergence [degrees]	0.92663550	0.26013438
Point Scale	0.99976742	0.99996533
Combined Factor	0.99949170	0.99968955

US NATIONAL GRID DESIGNATOR: 10TFL1663897039(NAD 83)

BASE STATIONS USED

<u>PID</u>	<u>DESIGNATION</u>	<u>LATITUDE</u>	<u>LONGITUDE</u>	<u>DISTANCE(m)</u>
DN7461	P674 GLASSMTN__CN2006 CORS ARP	N413658.746	W1212923.893	14512.9
DK6408	P347 ADINCTYARDCN2007 CORS ARP	N411100.021	W1205654.407	66063.9
DN7398	P348 HATCHETMTNCN2005 CORS ARP	N405419.951	W1214940.756	70464.1
NEAREST NGS PUBLISHED CONTROL POINT				
MW0525	Z 502	N413122.	W1213258.	4449.8

Ground Receiver UNIT 2 - 10/17/2013

START: 2013/10/17 13:02:00
STOP: 2013/10/17 17:00:00

ANT NAME: LEIAX1202 NONE # FIXED AMB: 105 / 122 : 86%

ARP HEIGHT: 1.6168 OVERALL RMS: 0.016(m)

REF FRAME: NAD_83(2011)(EPOCH:2010.0000) IGS08 (EPOCH:2013.7935)

X:	-2506892.490(m)	0.012(m)	-2506893.347(m)	0.012(m)
Y:	-4074714.171(m)	0.004(m)	-4074712.917(m)	0.004(m)
Z:	4206664.042(m)	0.003(m)	4206664.033(m)	0.003(m)
LAT:	41 30 57.42454	0.003(m)	41 30 57.43762	0.003(m)
E LON:	238 23 55.90161	0.011(m)	238 23 55.84181	0.011(m)
W LON:	121 36 4.09839	0.011(m)	121 36 4.15819	0.011(m)
EL HGT:	1757.758(m)	0.007(m)	1757.289(m)	0.007(m)
ORTHO HGT:	1780.769(m)	0.025(m)	[NAVD88 (Computed using GEOID12A)]	

UTM COORDINATES STATE PLANE COORDINATES

	UTM (Zone 10)	SPC (0401 CA 1)
Northing (Y) [meters]	4596979.694	742434.994
Easting (X) [meters]	616725.638	2033293.965
Convergence [degrees]	0.92730983	0.26080931
Point Scale	0.99976767	0.99996521
Combined Factor	0.99949210	0.99968959

US NATIONAL GRID DESIGNATOR: 10TFL1672596979(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DN7464 P730	BALLARDRDGCN2007 CORS ARP	N412133.095	W1204941.645	66919.7
DN7461 P674	GLASSMTN__CN2006 CORS ARP	N413658.746	W1212923.893	14504.6
DN5668 P663	SHWHALEBAKCN2007 CORS ARP	N413154.969	W1220910.465	46104.6

NEAREST NGS PUBLISHED CONTROL POINT				
MW0525	Z 502	N413122.	W1213258.	4375.1

Ground Receiver UNIT 1 - 10/18/2013

START: 2013/10/18 12:51:00
STOP: 2013/10/18 21:00:00

ANT NAME: LEIAX1202 NONE # FIXED AMB: 84 / 89 : 94%

ARP HEIGHT: 1.6488 OVERALL RMS: 0.012(m)

REF FRAME: NAD_83(2011)(EPOCH:2010.0000) IGS08 (EPOCH:2013.7964)

X:	-2506945.003(m)	0.002(m)	-2506945.860(m)	0.002(m)
Y:	-4074635.054(m)	0.005(m)	-4074633.800(m)	0.005(m)
Z:	4206710.581(m)	0.008(m)	4206710.572(m)	0.008(m)
LAT:	41 30 59.41006	0.003(m)	41 30 59.42314	0.003(m)
E LON:	238 23 52.18582	0.002(m)	238 23 52.12601	0.002(m)
W LON:	121 36 7.81418	0.002(m)	121 36 7.87399	0.002(m)
EL HGT:	1758.754(m)	0.009(m)	1758.285(m)	0.009(m)
ORTHO HGT:	1781.763(m)	0.027(m)	[NAVD88 (Computed using GEOID12A)]	

	UTM COORDINATES	STATE PLANE COORDINATES
	UTM (Zone 10)	SPC (0401 CA 1)
Northing (Y) [meters]	4597039.533	742495.855
Easting (X) [meters]	616638.518	2033207.530
Convergence [degrees]	0.92663552	0.26013440
Point Scale	0.99976742	0.99996533
Combined Factor	0.99949170	0.99968955

US NATIONAL GRID DESIGNATOR: 10TFL1663897039(NAD 83)

BASE STATIONS USED						
PID	DESIGNATION			LATITUDE	LONGITUDE	DISTANCE(m)
DN7461	P674 GLASSMTN__CN2006	CORS	ARP	N413658.746	W1212923.893	14512.9
DN7464	P730 BALLARDRDGCN2007	CORS	ARP	N412133.095	W1204941.645	67018.7
DN7398	P348 HATCHETMTNCN2005	CORS	ARP	N405419.951	W1214940.756	70464.1
NEAREST NGS PUBLISHED CONTROL POINT						
MW0525	Z 502			N413122.	W1213258.	4449.8

Ground Receiver UNIT 2 - 10/18/2013

START: 2013/10/18 12:58:00
STOP: 2013/10/18 21:00:00

ANT NAME: LEIAX1202 NONE # FIXED AMB: 115 / 134 : 86%

ARP HEIGHT: 1.6238 OVERALL RMS: 0.016(m)

REF FRAME: NAD_83(2011)(EPOCH:2010.0000) IGS08 (EPOCH:2013.7964)

X:	-2506892.493(m)	0.013(m)	-2506893.350(m)	0.013(m)
Y:	-4074714.175(m)	0.005(m)	-4074712.921(m)	0.005(m)
Z:	4206664.045(m)	0.003(m)	4206664.036(m)	0.003(m)
LAT:	41 30 57.42451	0.002(m)	41 30 57.43758	0.002(m)
E LON:	238 23 55.90159	0.012(m)	238 23 55.84179	0.012(m)
W LON:	121 36 4.09841	0.012(m)	121 36 4.15821	0.012(m)
EL HGT:	1757.764(m)	0.006(m)	1757.294(m)	0.006(m)
ORTHO HGT:	1780.775(m)	0.025(m)	[NAVD88 (Computed using GEOID12A)]	

	UTM COORDINATES	STATE PLANE COORDINATES
	UTM (Zone 10)	SPC (0401 CA 1)
Northing (Y) [meters]	4596979.692	742434.993
Easting (X) [meters]	616725.637	2033293.965
Convergence [degrees]	0.92730982	0.26080931
Point Scale	0.99976767	0.99996521
Combined Factor	0.99949210	0.99968959

US NATIONAL GRID DESIGNATOR: 10TFL1672596979(NAD 83)

BASE STATIONS USED						
PID	DESIGNATION			LATITUDE	LONGITUDE	DISTANCE(m)
DN7464	P730	BALLARDRDGCN2007	CORS ARP	N412133.095	W1204941.645	66919.7
DN5668	P663	SHWHALEBAKCN2007	CORS ARP	N413154.969	W1220910.465	46104.6
DN7461	P674	GLASSMTN__CN2006	CORS ARP	N413658.746	W1212923.893	14504.6
NEAREST NGS PUBLISHED CONTROL POINT						
MW0525	Z	502		N413122.	W1213258.	4375.1

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.

HARRIS/ MEDICINE LAKE VOLCANO LIDAR 2013 / DIGITAL MAPPING INC./ UTM 10

<u>AERIAL POINT#</u>	<u>LATITUDE</u>	<u>LONGITUDE</u>	<u>NORTH (M)</u>	<u>EAST (M)</u>	<u>TARGET ELEV.</u>	<u>DESCRIPTION</u>
AT 1	41°25'04.68021" N	121°46'18.65878" W	4585884.787	602635.075	1470.732	SET 60D SPIKE
AT 2	41°25'10.84598" N	121°43'26.15626" W	4586132.837	606636.753	1417.413	SET 60D SPIKE
AT 3	41°26'06.94106" N	121°45'06.52792" W	4587828.803	604281.841	1445.385	SET 60D SPIKE
AT 4	41°27'23.92278" N	121°46'38.63974" W	4590172.353	602110.587	1475.995	SET 60D SPIKE
AT 5	41°27'49.20293" N	121°43'25.27649" W	4591016.756	606585.162	1484.466	SET 60D SPIKE
AT 6	41°29'51.29966" N	121°44'49.44543" W	4594753.614	604578.082	1692.638	SET 60D SPIKE
AT 7	41°29'42.95361" N	121°46'32.10780" W	4594462.124	602201.435	1622.057	SET 60D SPIKE
AT 8	41°31'57.02908" N	121°44'01.05214" W	4598647.414	605643.299	1752.788	SET 60D SPIKE
AT 9	41°32'16.07433" N	121°46'50.40227" W	4599178.312	601710.630	1830.961	SET 60D SPIKE
AT 10	41°33'53.78440" N	121°43'38.35386" W	4602255.860	606116.235	2037.072	SET 60D SPIKE
AT 11	41°33'05.80584" N	121°40'32.95066" W	4600840.779	610433.168	1856.632	SET 60D SPIKE
AT 12	41°32'04.31569" N	121°37'41.59408" W	4599006.384	614433.011	1857.980	SET 60D SPIKE
AT 13	41°34'33.82662" N	121°33'41.31753" W	4603707.882	619924.043	2089.876	SET 60D SPIKE
AT 14	41°34'42.23403" N	121°39'33.43437" W	4603835.899	611765.772	2198.037	SET 60D SPIKE
AT 15B	41°37'16.61139" N	121°43'25.46439" W	4608515.466	606322.265	1662.717	SET 60D SPIKE
AT 16	41°39'29.83009" N	121°42'09.53685" W	4612650.193	608017.518	1573.544	SET 60D SPIKE
AT 17	41°38'04.57141" N	121°39'23.13197" W	4610079.744	611907.161	1835.090	SET 60D SPIKE
AT 18	41°39'31.06560" N	121°35'13.73647" W	4612839.505	617633.661	1866.741	SET 60D SPIKE
AT 19	41°36'41.67355" N	121°31'07.15022" W	4607711.115	623426.542	2121.287	SET 60D SPIKE
AT 19A	41°35'50.39406" N	121°34'28.44049" W	4606051.140	618793.776	2042.691	SET 60D SPIKE
AT 20	41°35'17.03875" N	121°31'28.76823" W	4605092.367	622970.822	661.944	SET 60D SPIKE
AT 21	41°36'29.00383" N	121°28'18.32709" W	4607388.540	627340.913	1841.878	SET 60D SPIKE
AT 22	41°38'01.98004" N	121°26'39.35334" W	4610296.939	629580.085	1497.266	SET 60D SPIKE
AT 23	41°34'43.78465" N	121°26'14.23394" W	4604194.983	630272.008	1512.421	SET 60D SPIKE

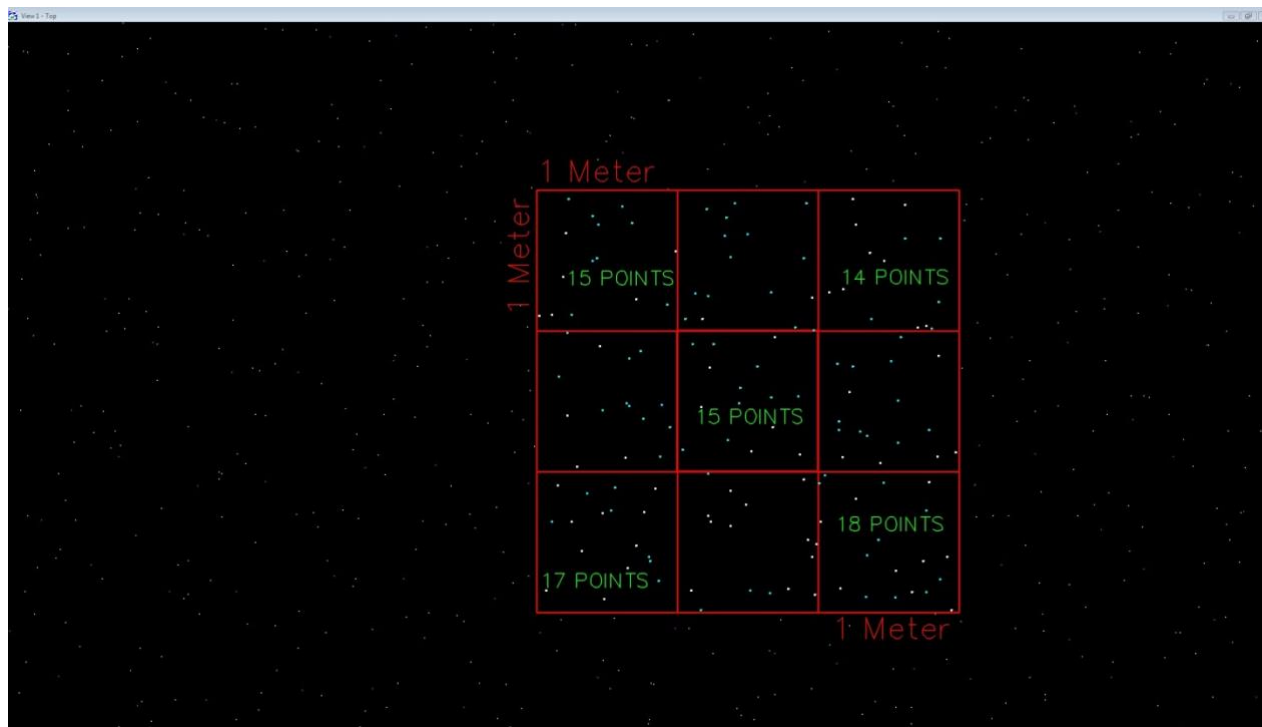
CORS SITES USED (PLEASE REFER TO OPUS DATA SHEETS)

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 > 9 points

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- ALL DAYS



10/8/2013



10/16/2013



10/17/2013



10/18/2013

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)

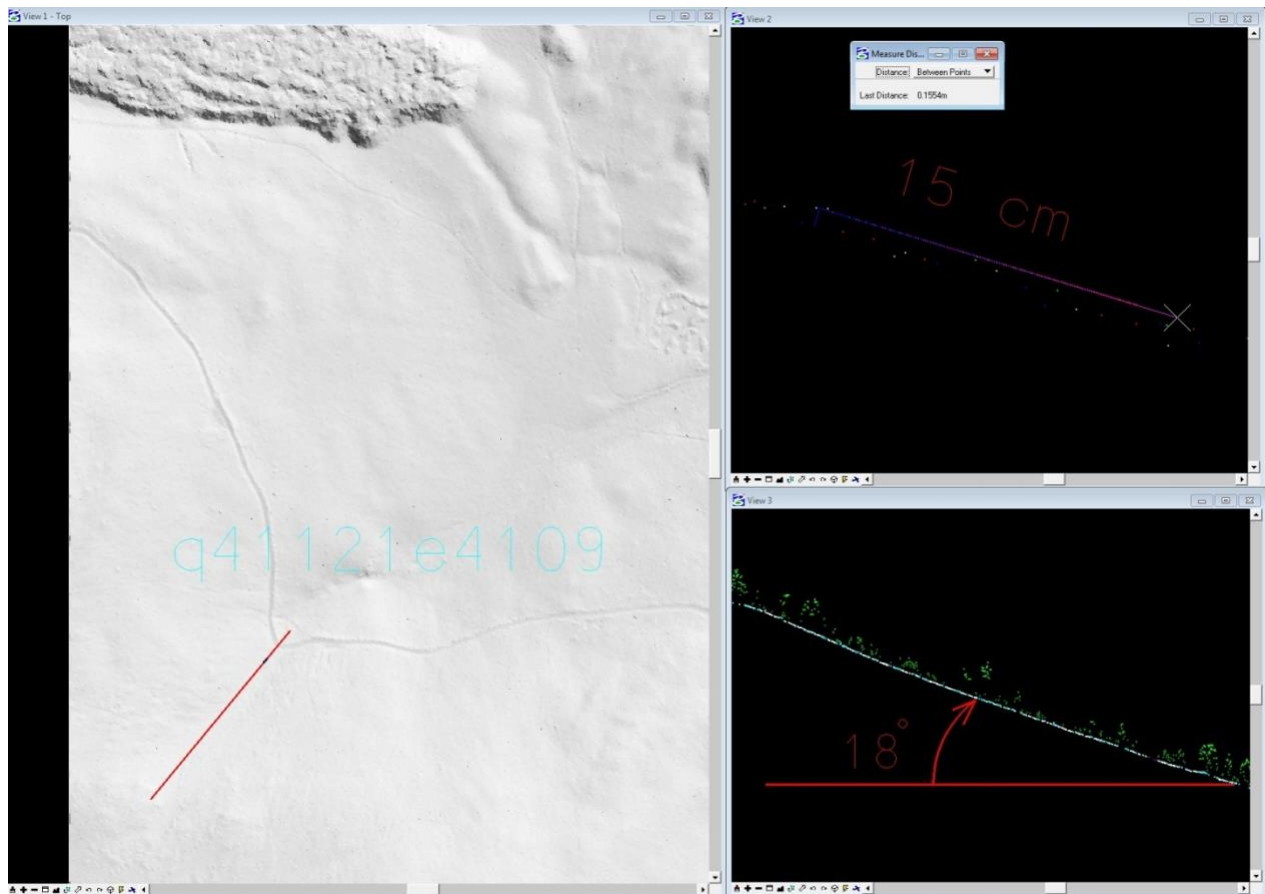
MEDICINE LAKE VOLCANO / HARRIS

Number	Easting	Northing	Known Z	Laser Z	Dz
AT-1	602635.075	4585884.787	1470.732	1470.490	-0.242
AT-2	606636.753	4586132.837	1417.413	1417.260	-0.153
AT-3	604281.841	4587828.803	1445.385	1445.440	+0.055
AT-4	602110.587	4590172.353	1475.995	1476.030	+0.035
AT-5	606585.162	4591016.756	1484.466	1484.520	+0.054
AT-6	604578.082	4594753.614	1692.638	1692.730	+0.092
AT-7	602201.435	4594462.124	1622.057	1622.090	+0.033
AT-8	605643.299	4598647.414	1752.788	1752.820	+0.032
AT-9	601710.630	4599178.312	1830.961	1830.940	-0.021
AT-10	606116.235	4602255.860	2037.072	2037.140	+0.068
AT-11	610433.168	4600840.779	1856.632	1856.640	+0.008
AT-12	614433.011	4599006.384	1857.980	1857.970	-0.010
AT-13	619924.043	4603707.882	2089.876	2089.850	-0.026
AT-14	611765.772	4603835.899	2198.037	2198.060	+0.023
AT-15B	606322.265	4608515.466	1662.717	1662.770	+0.053
AT-16	608017.518	4612650.193	1573.544	1573.570	+0.026
AT-17	611907.161	4610079.744	1835.090	1835.070	-0.020
AT-18	617633.661	4612839.505	1866.741	1866.660	-0.081
AT-19	623426.542	4607711.115	2121.287	2121.270	-0.017
AT-19A	618793.776	4606051.140	2042.691	2042.670	-0.021
AT-21	627340.913	4607388.540	1841.878	1841.910	+0.032

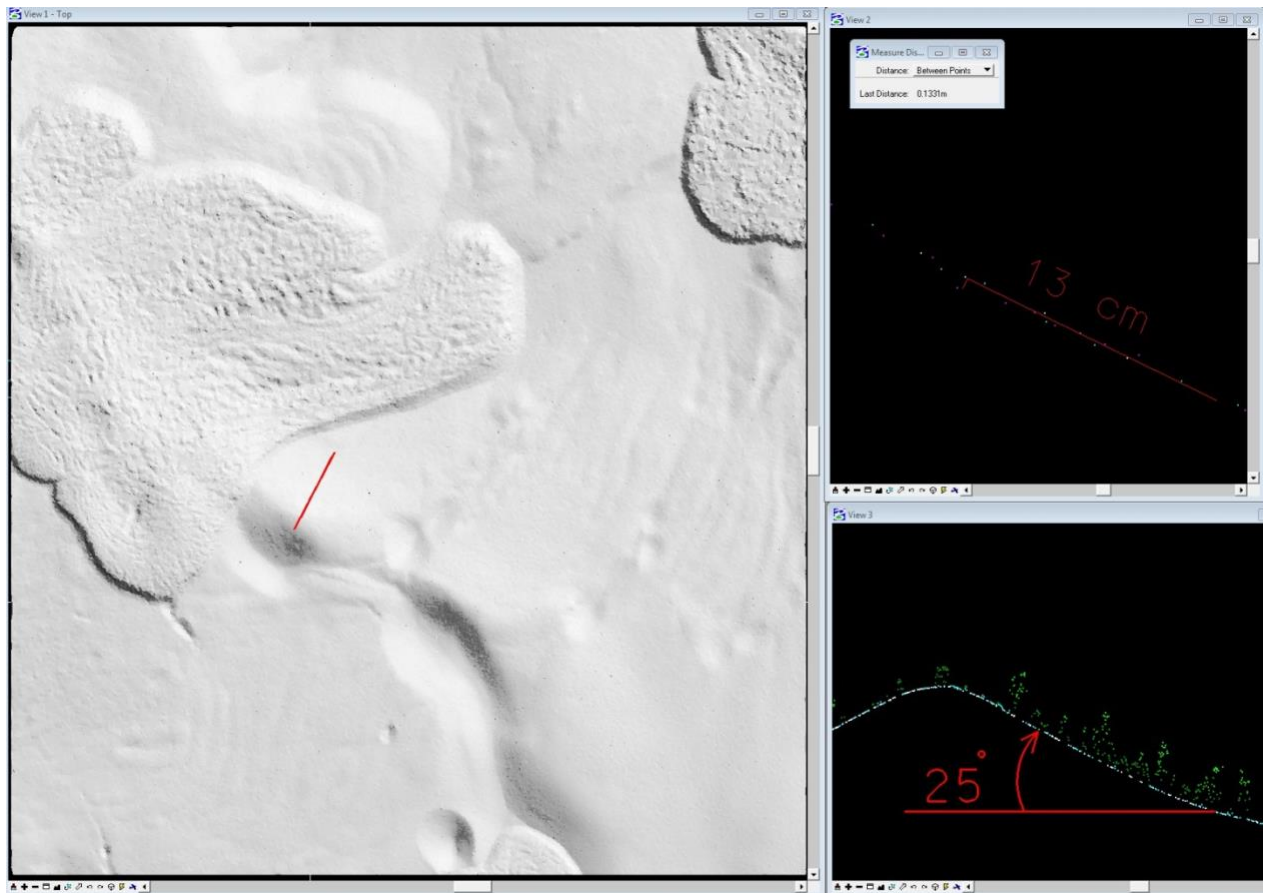
AT-22	629580.085	4610296.939	1497.266	1497.300	+0.034
AT-23	630272.008	4604194.983	1512.421	1512.380	-0.041

Average dz	-0.004
Minimum dz	-0.242
Maximum dz	+0.092
Average magnitude	0.051
Root mean square	0.073
Std deviation	0.074

18 DEGREE SLOPE



25 DEGREE SLOPE



FLAT AREA

