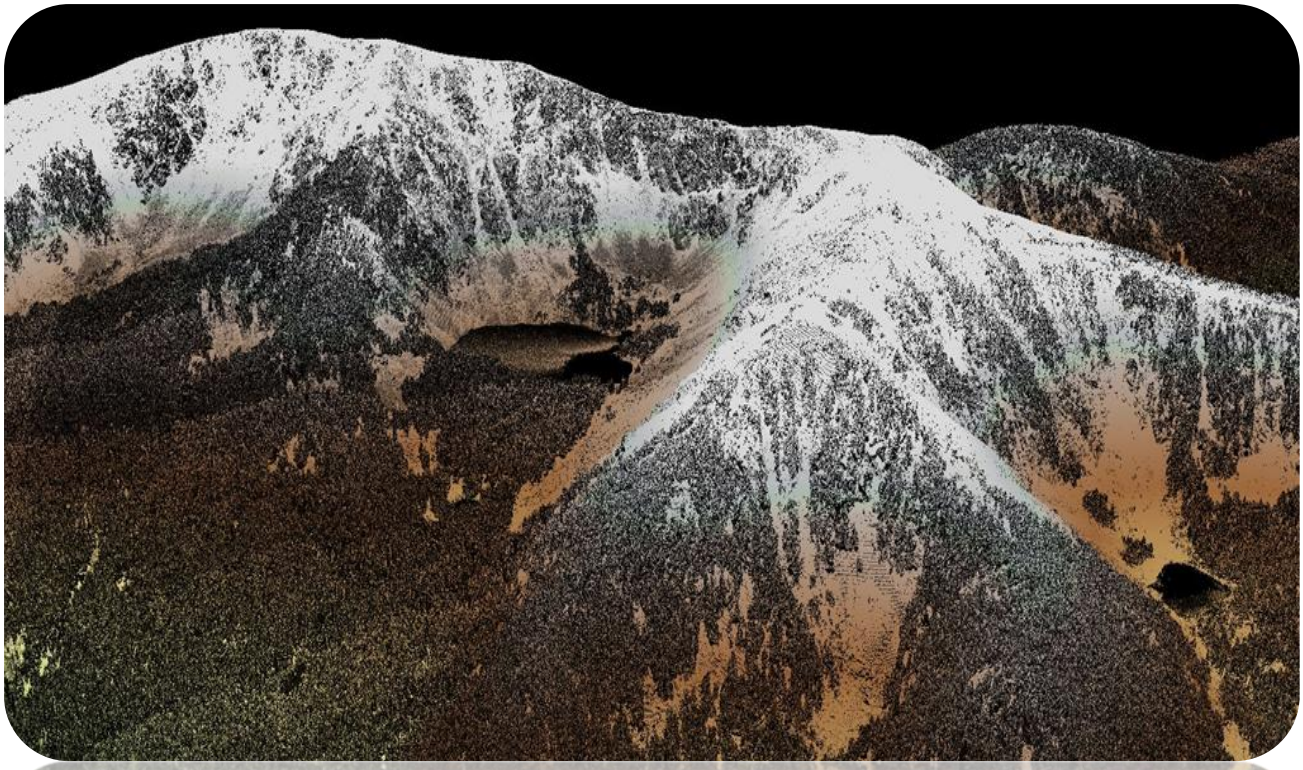
aero-graphics

TECHNICAL PROJECT REPORT

SANTA FE COUNTY LiDAR & IMAGERY ACQUISITION

SANTA FE COUNTY, NEW MEXICO

March-August, 2014



Bohannan Huston

Submitted to:

Dennis Sandin
Bohannan-Huston, Inc.
7500 Jefferson St. NE
Albuquerque, NM 87109

Submitted by:

Aero-Graphics, Inc.
40 W. Oakland Avenue
Salt Lake City, UT 84115
www.aero-graphics.com

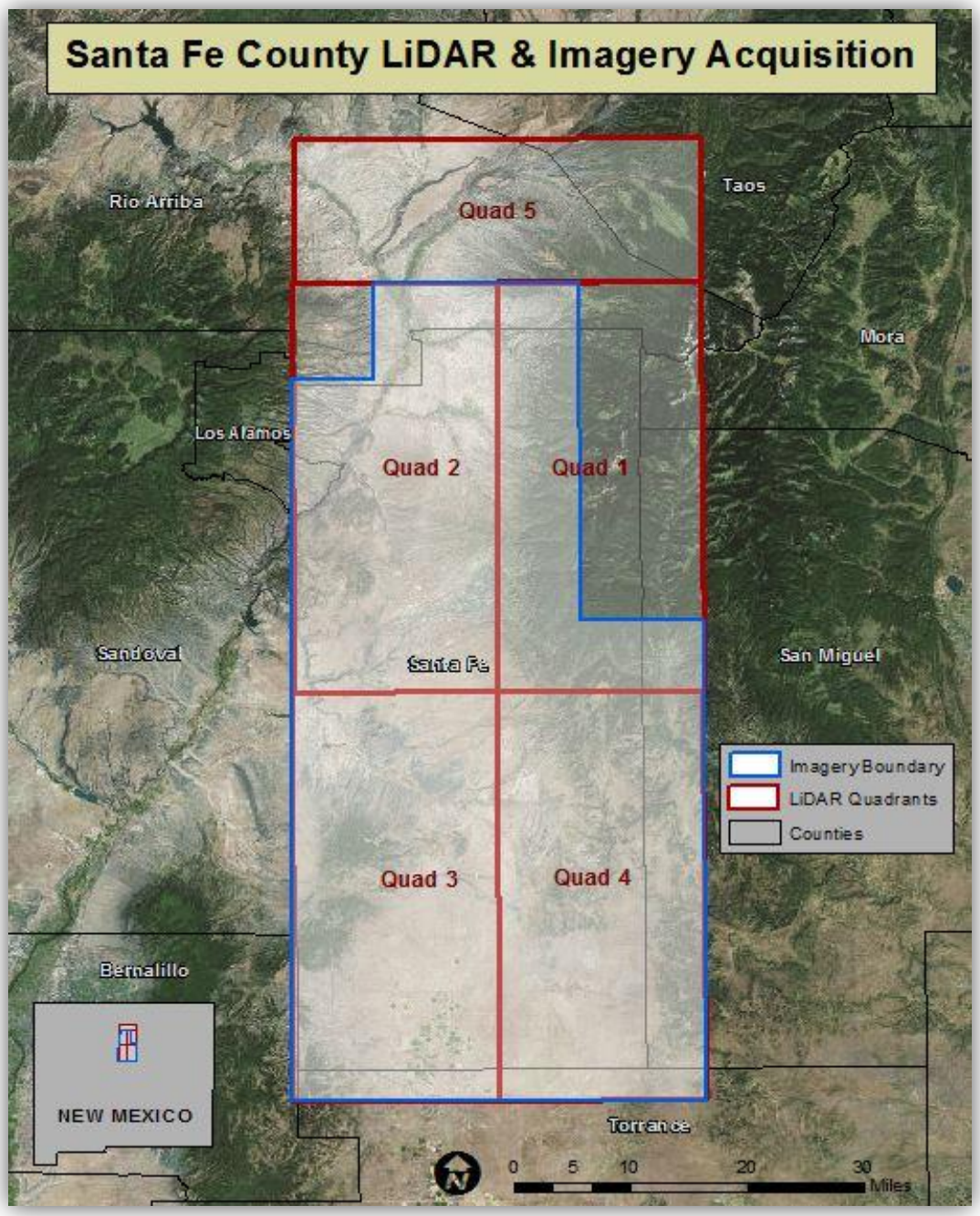
Technical Project Report
Santa Fe County LiDAR & Imagery Acquisition
Santa Fe County, New Mexico

Table of Contents

1. Overview

Between March 12 and August 11, 2014, Aero-Graphics acquired LiDAR data and 4-band stereo imagery over the entirety of Santa Fe County in New Mexico, as well as portions of Rio Arriba, Taos, Mora, Los Alamos, San Miguel, and Torrance Counties. The project area covers approximately 3,000 square miles of urban, desert, and mountain areas.

Exhibit 1: *Santa Fe County project boundaries*



2. Acquisition

2.1 Airborne Acquisition – Equipment and Methodology

2.1.1 LiDAR Acquisition

LiDAR acquisition of Santa Fe County was performed with an Optech ALTM Orion H300 LiDAR sensor. For quadrants 1 and 5 (composed of mountain areas with significant relief), Aero-Graphics flew at an average altitude of 4,039 ft AGL (above ground level) and made appropriate adjustments to compensate for topographic relief. The PRF (pulse repetition frequency) used for collection was 75 kHz, scan frequency of 42.3 Hz, and scan angle of +/- 12° from the nadir position (full scan angle 24°). For quadrants 2, 3, and 4 (primarily flatter desert areas), Aero-Graphics flew at an average altitude of 3,250 ft AGL. The PRF used for collection was 100 kHz, scan frequency of 44 Hz, and scan angle of +/-19° from the nadir position (full scan angle 38°). The Orion H300 features roll compensation that adjusts the mirror to maintain the full scan angle integrity in relation to nadir, even when less than perfect weather conditions push the sensor off nadir. Acquisition was performed with 30% overlap and yielded an average 5.9 points per square meter. The Orion H300 LiDAR sensor is capable of receiving up to four range measurements, including 1st, 2nd, 3rd, and last returns for every pulse sent from the system.

Exhibit 2: *Summary of flight parameters for Quadrants 1 and 5*

Altitude (ft AGL)	Overlap (%)	Speed (kts)	PRF (kHz)	Scan Freq (Hz)	Scan Angle ° (full)	PPM^2 (mean)	Post spacing Down Track (m)	Post Spacing Cross Track (m)	Swath Width (m)
4,039	30	105	75	42.3	24	2.42	0.6993	0.7002	523.36

Exhibit 3: *Summary of flight parameters for Quadrants 2, 3, and 4*

Altitude (ft AGL)	Overlap (%)	Speed (kts)	PRF (kHz)	Scan Freq (Hz)	Scan Angle ° (full)	PPM^2 (mean)	Post spacing Down Track (m)	Post Spacing Cross Track (m)	Swath Width (m)
3,250	30	120	100	44	38	2.37	0.7015	0.7016	682.18

The Orion H300 is also equipped with a GPS/IMU unit that continually records the XYZ position and roll, pitch and yaw attitude of the plane throughout the flight. This information allows us to correct laser return data positions that may have been thrown off by the plane's natural movement.

Exhibit 4: *The LiDAR acquisition platform for the Santa Fe County project was a turbocharged Cessna 206. Our 206 has been customized for LiDAR and other airborne sensors with an upgraded power system and avionics. The stability of the Cessna 206 is ideal for LiDAR collection.*

The ALTM Orion H300 LiDAR sensor is equipped with Optech FMS Planner Flight Management System Software. FMS Planner is the latest release from Optech, and is not only used to guide the airborne mission in flight, but our office flight planning is performed using the same software. This smooth transition from flight planning to aerial operations eliminates discrepancies between the flight plan and what is actually acquired. The use of FMS Planner helps ensure an accurate and consistent acquisition mission with real-time quality assurance while still airborne. The system operator can monitor the point density and swath during the mission to confirm adequate coverage within the area of interest, as shown in **Exhibit 5.**

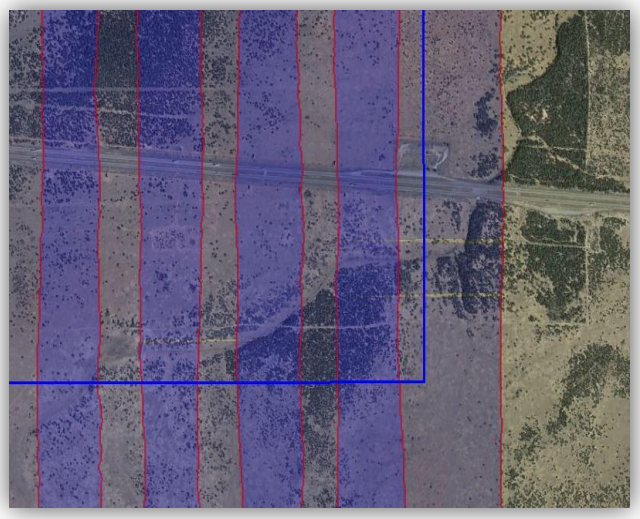


Exhibit 5: *Swath data for the Santa Fe County project was recorded and viewed real-time by the operator.*

Exhibit 6: *LiDAR acquisition begin and end times in Mountain Daylight Time*

March 12	March 13	March 16	March 17	March 24	March 25
11:47 – 16:38	12:06 – 16:20	08:32 – 19:51	15:53 – 20:36	08:03 – 20:05	09:07 – 14:04

April 14	April 15	April 16	April 17	April 18	April 19
17:32 – 20:21	07:32 – 19:03	07:45 – 20:35	13:38 – 19:33	07:08 – 20:34	07:24 – 12:25

May 02	May 03	May 04	May 29	May 30	May 31
07:31 – 19:38	07:58 – 17:56	08:10 – 12:50	07:35 – 13:10	06:50 – 09:47	06:10 – 16:20

June 01	June 02	June 03	June 05	June 06
07:00 – 12:51	05:18 – 16:15	05:22 – 15:45	12:38 – 16:21	04:50 – 09:20

August 05	August 06	August 07	August 08	August 09	Aug 10	Aug 11
06:04 – 10:07	05:59 – 10:26	06:28 – 11:24	06:21 – 11:41	06:31 – 11:26	06:40 – 11:47	07:14 – 08:46

2.1.2 Imagery Acquisition

Image acquisition was performed in conjunction with the LiDAR acquisition using the industry-leading Microsoft/Vexcel UltraCam Eagle (UCE) digital camera system. The imagery was acquired at an average elevation of 9,466 ft AGL, collecting 5,833 individual images over 36 flightlines, at a 15cm Ground Sampling Distance (GSD).

Exhibit 7: *Summary of flight parameters*

Altitude (ft AGL)	Overlap (%)	Sidelap (%)	# Flightlines	# Images
9,466	60	30	36	5,833

Exhibit 8: *Acquisition begin and end times in Mountain Daylight Time*

March 10	March 11	March 12	March 13	March 15	March 18	March 21
12:07 – 15:05	10:47 – 12:56	10:06 – 14:37	10:10 – 14:42	11:36 – 13:12	10:05 – 14:13	10:46 – 11:31

June 04	June 20
12:28 – 14:39	08:05 – 09:40

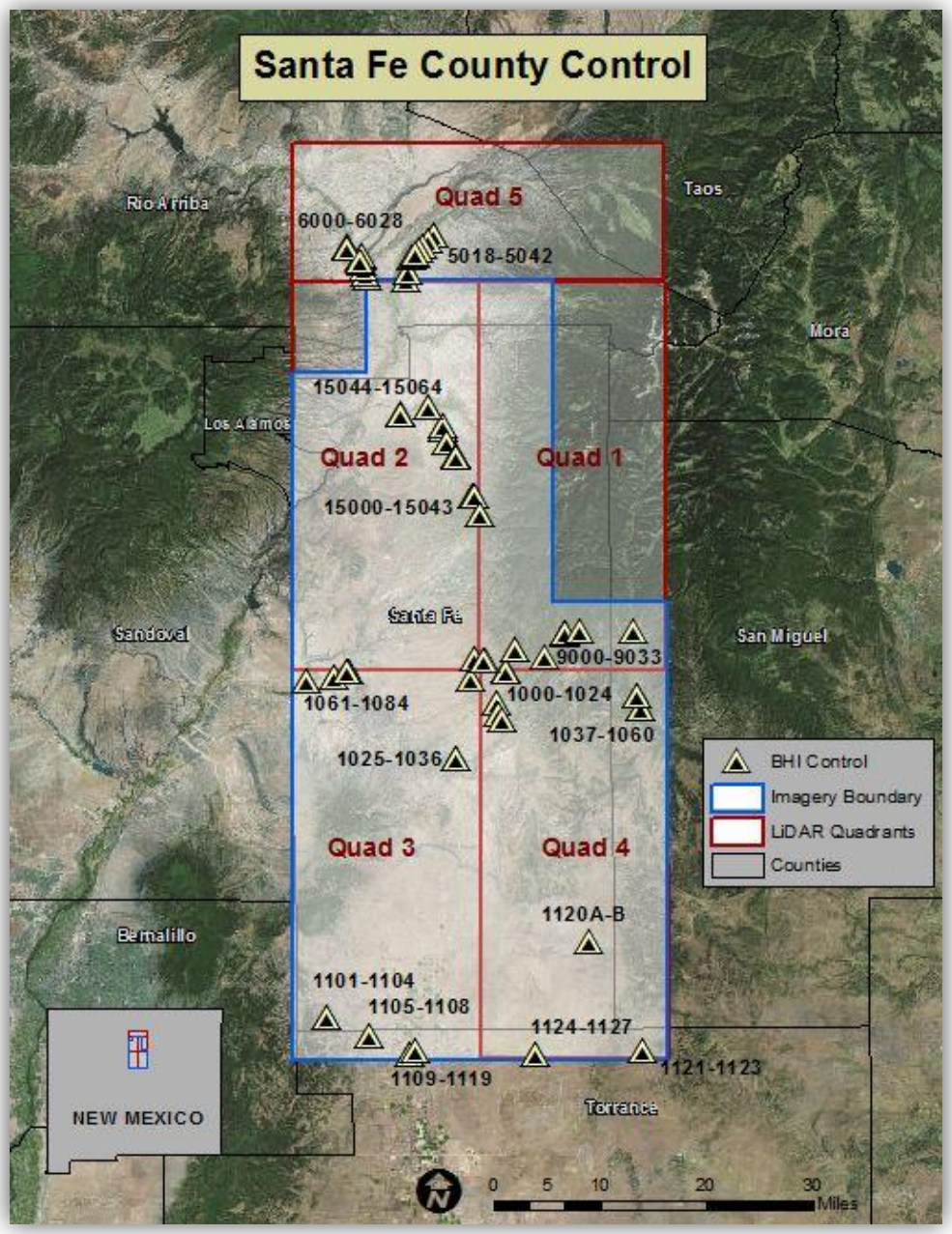
The UCE collected natural color and color infrared imagery simultaneously at a 16-bit radiometric resolution and were output as 8-bit to create the final 4-band images. Like the Orion, the UCE is also equipped with precision GPS/IMU to accurately position the raw imagery for orthorectification. In addition, it is equipped with Forward Motion Compensation and mounted in a GSM-3000 gyro-stabilized mount that works together with the IMU to automatically correct up to 5° roll, 8.4° pitch, and 6.2° yaw before each exposure is fired. The imagery was reviewed for completeness before mobilizing the imagery back to the office.

Exhibit 9: *The imagery acquisition platform for the Santa Fe County project was a Piper PA-46 Malibu. With a maximum cruise speed of 213 knots, our Malibu provided quick mobilization to and acquisition of the areas of interest.*

2.2 Ground Survey Control Point Locations

Aero-Graphics used CORS base stations and statically-collected survey data (acquired by BHI) at strategic points throughout the project area to ensure that the LiDAR and image data maintained its true geographic integrity. SmartBase (Imagery/LiDAR) and PPP (LiDAR) solutions were used to differentially correct the aircraft's trajectory data. Control point and base coordinates can be found in Appendix A. LiDAR positional accuracy can be found in section 4.2.

Exhibit10: *Static ground control for Santa Fe County*



3. LiDAR Processing Workflow

a. **Absolute Sensor Calibration.** Our absolute sensor calibration adjusted for the difference in roll, pitch, heading, and scale between the raw laser point cloud from the sensor and surveyed control points on the ground.

b. **Kinematic Air Point Processing.** Differentially corrected the 1-second airborne GPS positions with ground base station; combined and refined the GPS positions with 1/200-second IMU (roll-pitch-yaw) data through development of a smoothed best estimate of trajectory (SBET).

c. **Raw LiDAR Point Processing (Calibration).** Combined SBET with raw LiDAR range data; solved real-world position for each laser point; produced point cloud data by flight strip in ASPRS v1.2 .LAS format; output in NAD83 State Plane New Mexico Central Zone.

d. **Relative Calibration.** Performed relative calibration by correcting for roll, pitch, heading, and scale discrepancies between adjacent flightlines; tested resulting relative accuracy. Results presented in Section 4.1.

e. **Absolute Accuracy Assessment.** Performed comparative tests that showed Z-differences between each static survey point and the laser point surface. Results presented in Section 4.2.

4. Results

4.1 Relative Calibration Accuracy Results

Between-swath relative accuracy is defined as the elevation difference in overlapping areas between a given set of two adjacent flightlines. The statistics below are based on the comparison of the flightlines and points listed for each quadrant.

Quadrant 1: (119 flightlines, > 5 billion points)

- Between-swath relative accuracy **average** of 0.179 foot

Quadrant 2: (74 flightlines, > 4 billion points)

- Between-swath relative accuracy **average** of 0.112 foot

Quadrant 3: (72 flightlines, > 5 billion points)

- Between-swath relative accuracy **average** of 0.093 foot

Quadrant 4: (69 flightlines, > 4 billion points)

- Between-swath relative accuracy **average** of 0.082 foot

Quadrant 5: (76 flightlines, > 4 billion points)

- Between-swath relative accuracy **average** of 0.166 foot

Within-swath relative accuracy is the amount of vertical separation, or "noise," among a set of points on open, paved ground that should have the same elevation. The within-swath relative accuracy average is less than **0.026 foot.**

4.2 Fundamental Vertical Accuracy

Fundamental Vertical Accuracy (FVA) is defined as the elevation difference between open, unobstructed, typically hard-surface ground surveyed static points and the elevation of the LiDAR surface at that same horizontal location. The statistics of the results, including FVA, are presented here.

Exhibit 11: *Fundamental Vertical Accuracy (FVA) of Quadrant 1*

Accuracy$_z$: Tested 0.186 feet fundamental vertical accuracy at 95 percent confidence level in open terrain using RMSEz x 1.9600.	
Average Error = -0.001 ft	**RMSE = 0.095 ft**
Minimum Error = 0.187 ft	**σ = 0.096 ft**
Maximum Error = 0.269 ft	**2 σ = 0.192 ft**
Survey Sample Size: n = 32	

Exhibit 12: *Fundamental Vertical Accuracy (FVA) of Quadrant 2*

Accuracy$_z$: Tested 0.251 feet fundamental vertical accuracy at 95 percent confidence level in open terrain using RMSEz x 1.9600.	
Average Error = -0.001 ft	**RMSE = 0.128 ft**
Minimum Error = -0.314 ft	**σ = 0.129 ft**
Maximum Error = 0.230 ft	**2 σ = 0.258 ft**
Survey Sample Size: n = 83	

Exhibit 13: *Fundamental Vertical Accuracy (FVA) of Quadrant 3*

Accuracy$_z$: Tested 0.441 feet fundamental vertical accuracy at 95 percent confidence level in open terrain using RMSEz x 1.9600.	
Average Error = -0.004 ft	**RMSE = 0.225 ft**
Minimum Error = -0.0386 ft	**σ = 0.227 ft**
Maximum Error = 0.557 ft	**2 σ = 0.454 ft**
Survey Sample Size: n = 59	

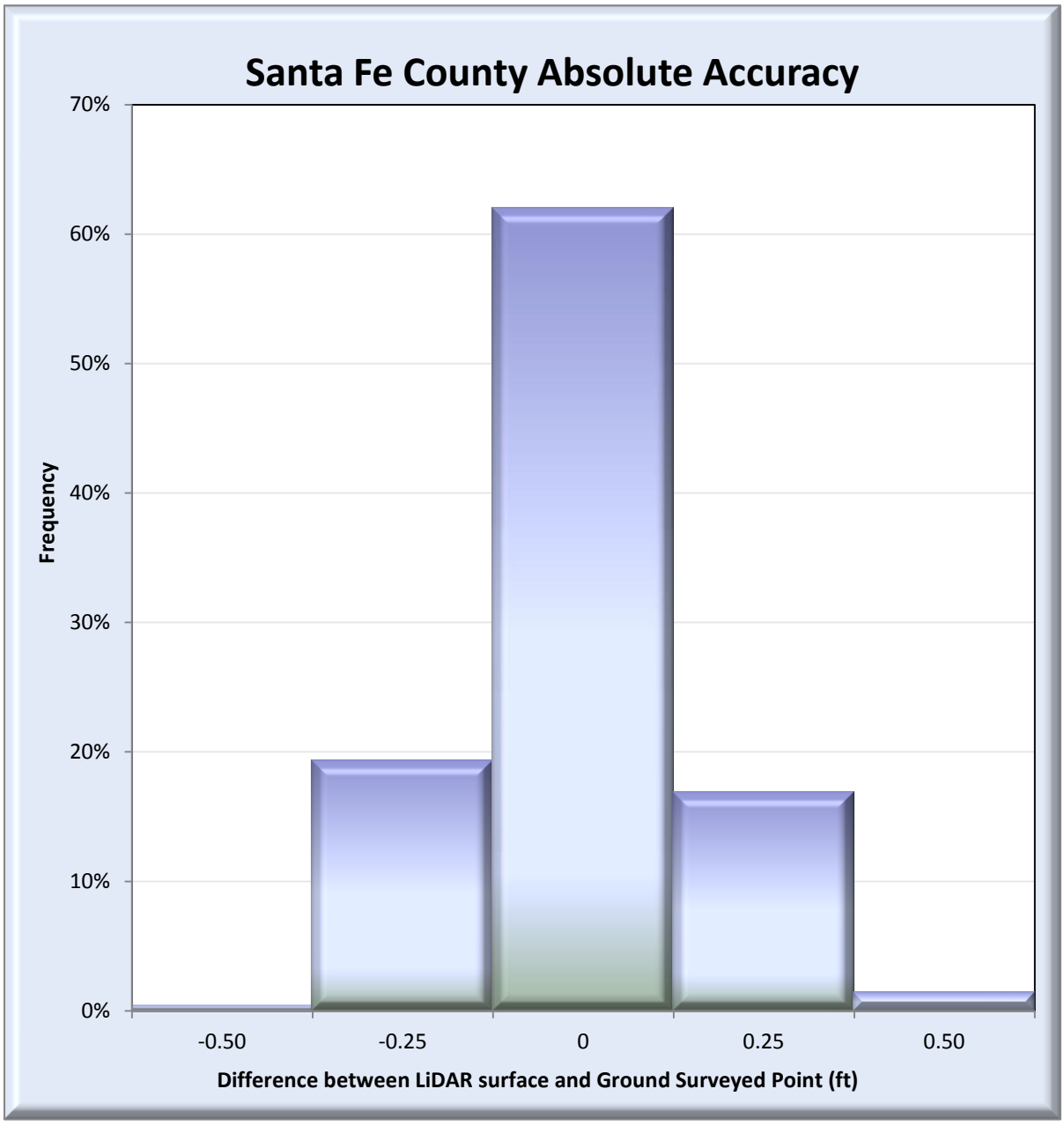
Exhibit 14: *Fundamental Vertical Accuracy (FVA) of Quadrant 4*

Accuracy$_z$: Tested 0.255 feet fundamental vertical accuracy at 95 percent confidence level in open terrain using RMSEz x 1.9600.	
Average Error = 0.015 ft	**RMSE = 0.130 ft**
Minimum Error = -0.254 ft	**σ = 0.131 ft**
Maximum Error = 0.244 ft	**2 σ = 0.262 ft**
Survey Sample Size: n = 49	

Exhibit 15: *Fundamental Vertical Accuracy (FVA) of Quadrant 5*

Accuracy$_z$: Tested 0.214 feet fundamental vertical accuracy at 95 percent confidence level in open terrain using RMSEz x 1.9600.	
Average Error = -0.002 ft	**RMSE = 0.109 ft**
Minimum Error = -0.256 ft	**σ = 0.110 ft**
Maximum Error = 0.261 ft	**2 σ = 0.220 ft**
Survey Sample Size: n = 56	

Exhibit 16: *Distribution of the errors between the LiDAR surface and Ground Surveyed points. Demonstrates the percentage of compared points within a given accuracy range.*



4.3 Data Density Summary

Santa Fe County	Goal	Actual (mean)
Total Point Density:	**4 points/m^2**	**5.9 points/m^2**

4.4 Projection, Datum, and Units

Projection:		State Plane New Mexico Central Zone
Ellipsoid:		GRS80
Datum	**Vertical:**	NAVD88
	Horizontal:	NAD 83 (1992 HARN)
Units:		U.S. Survey Feet

5. Deliverables

Point Data:	• Calibrated, fully-compliant LiDAR point data in .LAS 1.2 format
Vector Data:	• Trajectory data in ASCII format • Project Geodatabase containing flight and trajectory information for imagery acquisition
Raster Data:	• 4-band RGBi stereo imagery in TIFF format
Metadata	• None
Report of Survey:	• Technical Project Report including methodology, accuracy, and results

6. Highlighted Images

Exhibit 17: *LiDAR point cloud over Santa Fe (quadrant 1), colored by elevation and intensity values.*

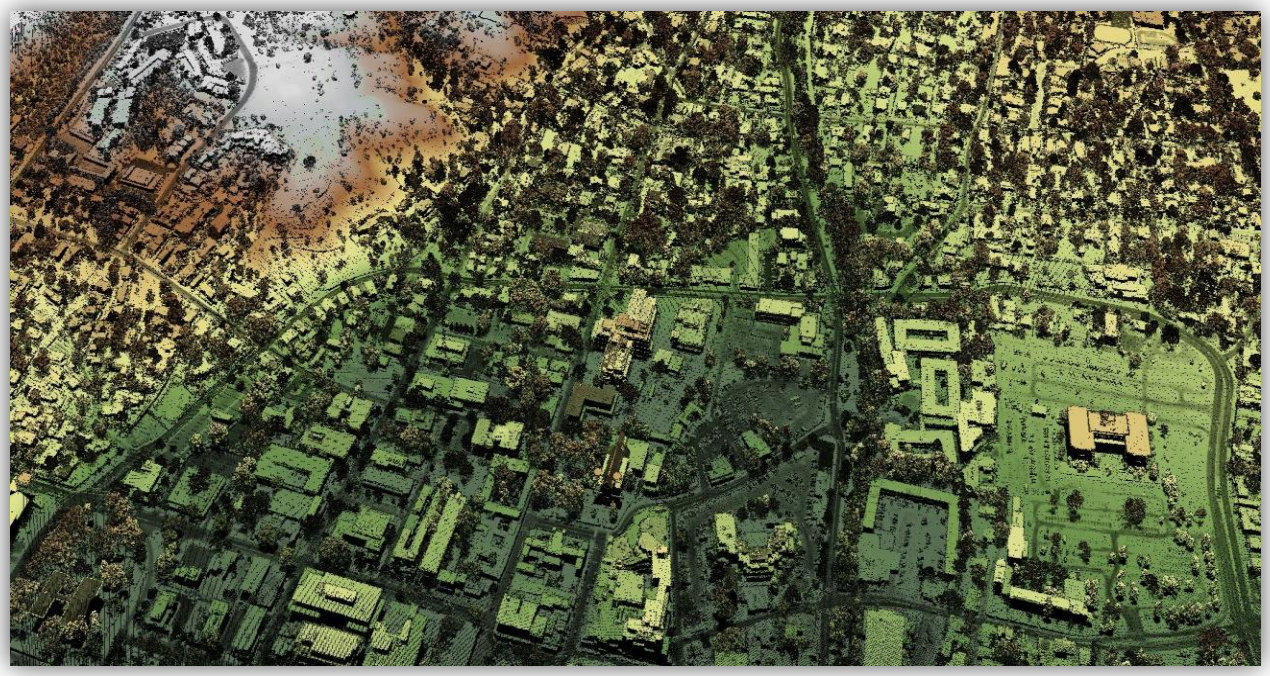
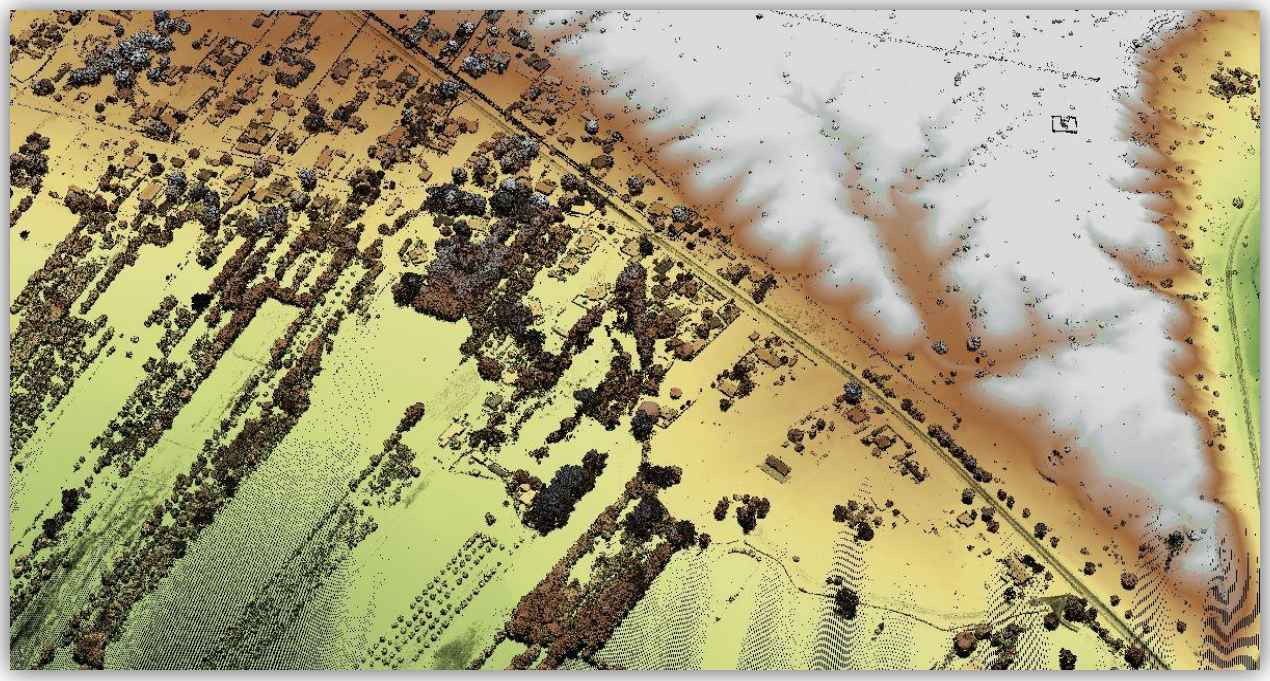


Exhibit 18: *LiDAR point cloud over Rio Arriba County (quadrant 5), colored by elevation and intensity values.*



Appendix A – Surveyed Ground Control and Base Stations

LiDAR Base Stations

Base Station	Datum: NAD 83 (1992 HARN)		WGS84
	Latitude	Longitude	Ellipsoid Height (m)
ABQ6	34° 57' 25.67468"	-106° 29' 40.14241"	1720.599
NMSF	35° 40' 25.64008"	-105° 57' 30.97640"	2096.261
P036	36° 25' 12.98644"	-105° 17' 37.15547"	2529.875
P070	36° 02' 41.20660"	-104° 41' 52.80320"	1883.504
P107	35° 07' 55.84769"	-107° 52' 48.07601"	1991.629
P120	35° 00' 26.83931"	-105° 37' 33.87668"	2089.635
P034	34° 56' 44.22891"	-106° 27' 33.36371"	1810.881
ZAB1	35° 10' 24.87026"	-106° 34' 02.45938"	1619.648
ZAB2	35° 10' 24.86804"	-106° 34' 02.23847"	1619.718
RG04	34° 49' 27.94530"	-105° 38' 38.96444"	2101.058
RG09	36° 18' 16.61222"	-107° 03' 21.18307"	2186.730
RG10	36° 27' 04.40770"	-106° 32' 18.80470"	2217.927
RG11	36° 31' 23.39606"	-105° 46' 44.76692"	2211.204
SC01	34° 04' 04.62804"	-106° 57' 59.55734"	2097.352

Imagery Base Stations

Base Station	Datum: NAD 83 (1992 HARN)		WGS84
	Latitude	Longitude	Ellipsoid Height (m)
ABQ6	34° 57' 25.67468"	-106° 29' 40.14241"	1720.599
P035	34° 36' 05.01341"	-105° 11' 00.97149"	1780.336
P036	36° 25' 12.98643"	-105° 17' 37.15548"	2529.875
P070	36° 02' 41.20660"	-104° 41' 52.80320"	1883.504
P107	35° 07' 55.84769"	-107° 52' 48.07601"	1991.629
P120	35° 00' 26.83931"	-105° 37' 33.87668"	2089.635
ZAB2	35° 10' 24.86804"	-106° 34' 02.23847"	1619.718

Survey Point	Datum: NAD 83 (1992 HARN)		NAVD88 (Geoid12A)
	Easting (US Foot)	Northing (US Foot)	Elevation (US Foot)
1000	1731570.215	1654123.341	6698.263
1001	1731570.729	1654122.520	6698.317
1002	1731584.269	1654130.921	6698.735
1003	1731583.728	1654131.764	6698.716
1004	1729959.869	1644437.709	6634.594
1005	1729960.549	1644437.011	6634.706
1006	1729970.827	1644447.968	6634.923
1007	1729970.108	1644448.672	6634.890
1008	1746934.390	1648256.529	6929.437
1010	1746932.779	1648291.959	6929.388
1011	1746942.921	1648287.223	6929.692
1012	1746944.402	1648256.005	6929.389
1013	1742952.280	1631884.833	6606.947
1014	1742950.894	1631883.593	6606.977
1015	1742966.762	1631865.862	6606.380
1016	1742968.279	1631867.214	6606.387
1017	1743462.987	1626770.353	6443.102
1018	1743461.245	1626769.706	6443.127
1019	1743469.452	1626752.114	6442.627
1020	1743471.219	1626753.018	6442.612
1021	1745073.550	1624110.391	6402.184
1022	1745086.022	1624124.506	6402.516
1023	1745084.870	1624125.414	6402.584
1024	1745072.792	1624111.776	6402.297
1025	1722058.768	1604314.662	6049.719
1026	1722059.753	1604315.622	6049.810
1027	1722053.318	1604322.573	6050.175
1028	1722053.001	1604332.161	6050.727
1029	1722051.692	1604332.166	6050.702
1030	1722051.866	1604324.119	6050.245
1031	1722046.267	1604330.322	6050.506
1032	1722045.356	1604329.425	6050.428
1033	1722052.000	1604322.026	6050.134
1034	1722052.366	1604312.198	6049.474
1035	1722053.682	1604312.291	6049.497
1036	1722053.397	1604320.506	6050.038
1037	1814442.547	1629721.196	6848.186
1038	1814441.513	1629721.339	6848.219
1039	1814440.425	1629714.394	6848.333
1040	1814439.891	1629712.565	6848.365

Survey Point	Datum: NAD 83 (1992 HARN)		NAVD88 (Geoid12A)
	Easting (US Foot)	Northing (US Foot)	Elevation (US Foot)
1041	1814431.976	1629705.926	6848.682
1042	1814432.822	1629704.849	6848.694
1043	1814439.274	1629710.262	6848.439
1044	1814437.289	1629702.279	6848.614
1045	1814438.636	1629701.974	6848.556
1046	1814441.190	1629711.655	6848.354
1047	1814442.716	1629713.120	6848.291
1048	1814448.077	1629717.610	6848.128
1049	1814447.403	1629718.338	6848.123
1050	1814441.513	1629713.543	6848.329
1051	1814441.738	1629714.617	6848.298
1052	1811911.769	1636028.337	6775.669
1053	1811913.678	1636040.366	6775.616
1054	1811915.858	1636031.484	6775.663
1055	1811916.066	1636033.487	6775.685
1056	1811914.083	1636042.216	6775.633
1057	1811914.014	1636043.071	6775.636
1058	1811913.423	1636043.114	6775.619
1059	1811913.143	1636041.789	6775.634
1060	1811911.901	1636033.881	6775.669
1061	1647678.164	1643428.968	5670.497
1062	1647667.955	1643441.946	5670.264
1063	1647666.720	1643440.400	5670.313
1064	1647677.856	1643426.097	5670.575
1065	1661954.490	1644888.606	6183.178
1066	1661969.901	1644873.192	6183.051
1067	1661970.870	1644873.346	6183.068
1068	1661955.493	1644888.647	6183.167
1069	1668574.302	1647480.020	6123.374
1070	1668574.673	1647479.759	6123.390
1071	1668559.618	1647568.925	6123.021
1072	1668559.343	1647568.572	6123.005
1073	1668620.205	1647618.330	6121.236
1074	1668619.916	1647617.956	6121.266
1075	1668634.674	1647529.471	6121.578
1076	1668635.040	1647529.535	6121.581
1077	1668680.262	1647501.806	6120.614
1078	1668680.409	1647502.332	6120.580
1079	1668587.396	1647426.577	6123.413
1080	1668587.653	1647426.229	6123.386

Survey Point	Datum: NAD 83 (1992 HARN)		NAVD88 (Geoid12A)
	Easting (US Foot)	Northing (US Foot)	Elevation (US Foot)
1081	1668469.107	1647405.031	6127.603
1082	1668469.998	1647404.637	6127.604
1083	1668461.386	1647388.961	6127.720
1084	1668460.352	1647389.198	6127.742
1101	1657676.364	1476398.896	6707.041
1102	1657662.837	1476388.919	6708.015
1103	1657668.983	1476380.681	6708.042
1104	1657682.017	1476390.306	6707.203
1105	1679065.951	1467259.740	6417.902
1106	1679065.214	1467258.564	6417.961
1107	1679093.351	1467246.507	6417.206
1108	1679092.805	1467245.202	6417.189
1109	1699762.992	1457424.699	6228.313
1110	1699779.327	1457418.400	6228.687
1111	1699779.456	1457418.780	6228.677
1112	1699763.143	1457425.020	6228.465
1113	1699779.083	1457466.639	6228.361
1114	1699795.477	1457460.373	6228.629
1115	1699795.643	1457460.722	6228.619
1116	1699779.223	1457466.964	6228.454
1117	1701921.606	1459450.264	6226.801
1118	1701916.518	1459450.305	6226.706
1119	1701916.616	1459468.909	6226.695
1121	1815325.823	1459443.841	7069.408
1122	1815315.633	1459435.316	7069.457
1123	1815340.986	1459447.023	7069.589
1124	1761836.837	1457652.021	6563.711
1125	1761847.704	1457635.376	6563.997
1126	1761835.453	1457635.264	6563.562
1127	1761825.032	1457651.588	6563.287
5018	1711399.366	1864614.517	5813.619
5019	1711332.950	1864547.291	5814.398
5020	1711250.309	1864464.608	5815.344
5021	1711668.349	1864834.744	5811.07
5022	1711653.483	1864850.426	5811.350
5023	1711637.231	1864867.224	5810.892
5024	1708533.982	1861864.853	5817.894
5025	1708549.451	1861849.705	5818.213
5026	1708560.663	1861838.250	5818.019
5027	1706078.571	1859386.682	5801.460

Survey Point	Datum: NAD 83 (1992 HARN)		NAVD88 (Geoid12A)
	Easting (US Foot)	Northing (US Foot)	Elevation (US Foot)
5028	1706004.431	1859311.811	5802.633
5029	1703980.353	1857293.864	5798.191
5030	1703995.572	1857278.312	5798.576
5031	1697292.727	1842309.764	5742.097
5032	1697273.825	1842314.369	5742.579
5033	1697260.984	1842317.454	5742.615
5034	1698359.478	1846519.850	5748.356
5035	1698353.752	1846521.245	5748.551
5036	1698357.200	1846523.355	5748.432
5037	1698355.931	1846517.507	5748.390
5038	1700209.521	1853180.792	5745.565
5039	1700231.204	1853216.849	5745.854
5040	1700267.527	1853276.598	5746.168
5041	1701710.172	1854809.618	5766.086
5042	1701685.064	1854784.074	5765.793
6000	1674283.579	1852955.149	5715.851
6001	1674230.553	1853077.823	5716.913
6002	1674402.751	1853148.751	5717.345
6003	1675253.295	1853524.939	5719.810
6004	1675229.461	1853556.538	5717.485
6005	1675458.682	1853753.406	5716.751
6006	1675483.072	1853721.224	5719.329
6007	1675794.068	1854330.272	5716.950
6008	1675773.779	1854263.733	5717.093
6009	1675751.545	1854202.022	5717.311
6010	1667934.057	1858992.062	5775.188
6011	1667925.979	1858992.043	5775.264
6012	1667926.723	1858975.794	5775.294
6013	1667934.180	1858975.524	5775.146
6014	1667799.302	1858324.708	5775.733
6015	1667806.482	1858324.124	5775.225
6016	1667805.712	1858309.772	5775.557
6017	1667798.336	1858310.179	5775.904
6018	1667802.153	1858316.985	5775.999
6019	1678352.837	1843035.351	5710.580
6020	1678342.196	1843074.153	5711.608
6021	1677356.862	1845767.609	5729.436
6022	1677408.892	1845647.310	5728.526
6023	1677477.421	1845663.836	5726.204
6024	1677569.466	1845669.589	5722.055

Survey Point	Datum: NAD 83 (1992 HARN)		NAVD88 (Geoid12A)
	Easting (US Foot)	Northing (US Foot)	Elevation (US Foot)
6025	1676188.637	1848424.916	5734.066
6026	1676171.156	1848465.179	5733.773
6027	1675110.162	1850932.457	5716.040
6028	1675093.231	1850971.720	5715.834
9000	1736295.794	1653726.907	6789.050
9001	1736319.276	1653727.423	6789.452
9002	1736316.829	1653720.219	6789.336
9003	1736298.048	1653734.176	6789.251
9004	1736567.111	1653658.152	6793.252
9005	1736543.400	1653657.881	6792.798
9006	1736564.784	1653650.823	6793.449
9007	1736546.030	1653665.045	6792.621
9008	1751401.186	1658469.800	7176.509
9009	1751420.393	1658480.751	7176.393
9010	1751347.666	1658537.344	7177.826
9011	1751358.036	1658543.304	7177.783
9013	1766184.963	1654755.595	6963.091
9014	1766184.073	1654754.998	6963.133
9016	1776058.159	1666591.618	7371.489
9017	1776060.609	1666619.224	7372.832
9018	1776074.836	1666638.922	7373.734
9019	1776094.605	1666660.309	7374.943
9020	1776113.918	1666679.595	7376.247
9021	1776133.918	1666697.817	7377.620
9022	1776153.591	1666714.189	7379.129
9023	1776179.153	1666734.000	7381.058
9024	1776223.633	1666767.246	7384.943
9025	1776266.056	1666798.508	7389.054
9026	1776308.890	1666830.078	7393.282
9027	1776352.385	1666862.184	7397.360
9028	1776397.382	1666895.246	7401.421
9029	1776451.265	1666934.530	7405.916
9030	1784056.642	1668053.100	7425.022
9031	1784066.082	1668058.947	7425.192
9032	1810924.431	1667814.329	6941.611
9033	1810924.239	1667847.154	6941.286
15000	1694988.872	1775974.218	5784.104
15001	1695111.268	1775956.053	5784.603
15002	1695173.739	1775674.095	5784.220
15003	1694988.756	1775674.446	5784.183

Survey Point	Datum: NAD 83 (1992 HARN)		NAVD88 (Geoid12A)
	Easting (US Foot)	Northing (US Foot)	Elevation (US Foot)
15004	1694814.552	1775542.893	5785.808
15005	1694683.173	1775555.334	5778.032
15006	1694896.877	1775520.768	5792.530
15007	1715667.312	1768356.351	6053.679
15009	1715666.246	1768339.177	6053.462
15010	1715576.643	1768345.689	6049.748
15011	1715634.606	1768395.217	6052.112
15012	1715659.434	1768393.388	6053.374
15013	1715696.616	1768391.704	6055.163
15014	1715656.719	1768283.692	6052.028
15015	1715799.675	1769818.574	6043.879
15016	1715800.014	1769777.399	6043.841
15017	1715769.390	1769746.754	6042.440
15018	1715768.700	1769746.681	6042.399
15019	1715768.843	1769730.718	6042.977
15020	1715769.570	1769730.730	6043.027
15021	1717392.428	1761496.294	6186.516
15022	1717393.795	1761494.844	6186.563
15023	1717392.679	1761496.452	6186.517
15024	1717405.917	1761505.353	6186.674
15025	1717406.984	1761503.877	6186.710
15026	1717332.702	1761369.334	6181.197
15027	1717333.732	1761367.616	6181.177
15028	1717324.035	1761360.933	6180.812
15029	1717322.867	1761362.453	6180.817
15030	1708507.507	1779319.660	5860.946
15031	1708459.523	1779370.882	5860.568
15032	1708429.143	1779410.549	5860.594
15033	1708359.136	1779475.698	5860.484
15034	1708456.552	1779562.885	5863.226
15035	1721898.721	1754927.461	6319.483
15037	1721917.084	1754938.791	6320.305
15038	1721935.443	1754938.263	6320.815
15039	1722015.550	1754949.016	6323.859
15040	1721998.818	1754729.393	6319.887
15041	1721961.552	1754738.863	6318.508
15042	1721920.629	1754719.454	6315.802
15043	1721882.088	1754688.364	6313.488
15044	1731023.177	1735392.678	6776.513
15045	1731023.220	1735391.784	6776.534

Survey Point	Datum: NAD 83 (1992 HARN)		NAVD88 (Geoid12A)
	Easting (US Foot)	Northing (US Foot)	Elevation (US Foot)
15046	1731035.776	1735391.869	6776.139
15047	1731036.068	1735392.697	6776.077
15048	1731083.036	1735462.008	6773.294
15049	1731095.149	1735437.535	6774.059
15050	1731094.183	1735437.626	6774.069
15051	1731093.036	1735415.480	6774.649
15052	1731093.873	1735415.282	6774.661
15053	1734454.615	1725813.814	7013.780
15054	1734450.568	1725807.070	7014.308
15055	1734457.135	1725802.907	7014.432
15056	1734461.322	1725809.709	7014.036
15057	1734455.880	1725808.331	7014.147
15058	1734504.098	1726339.350	6988.537
15059	1734507.163	1726339.128	6988.578
15060	1734507.514	1726343.058	6988.414
15061	1734504.416	1726343.212	6988.485
15062	1734450.493	1726328.432	6993.524
15063	1734438.829	1726309.315	6994.394
15064	1734416.123	1726352.754	6992.141
14344200	1702412.329	1855510.507	5782.288
14344201	1674593.200	1851909.544	5708.246
1120A	1788212.041	1513345.023	6922.994
1120B	1788212.026	1513345.019	6922.965