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Casper, WY
2015 Orthophoto Imagery Project

Aerial Triangulation Report – 3in Imagery

January 15, 2016

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EXECUTIVE SUMMARY

Sanborn has successfully completed the aerial triangulation (AT) task for the 3in aerial photography acquired April 29th through June 12th, 2015 for the Casper, WY Digital Orthophotography project.

Using fully analytical aerial triangulation (FAAT) methods incorporating automatic analytical aerial triangulation (AAAT) procedures, Sanborn determined ground coordinates for each exposure by flying at an average altitude of 9000ft AMSL covering the project area.

The results of the final adjustment are sufficient to enable Sanborn to produce orthophoto imagery with an appropriate ground pixel resolution that meets project accuracy requirements (ASPRS Class 1 for 1”=50’ mapping).

AT Accuracy Statement

The mean standard deviation of all adjusted terrain points indicates the theoretical accuracy of the bundle adjustment. Based on these statistics, along with the RMSE at control points and the overall bundle adjustment results (page 12), the AT solution exceeds the accuracy requirements for ASPRS Class 1 1”=50’ planimetric mapping and the generation of ortho imagery.

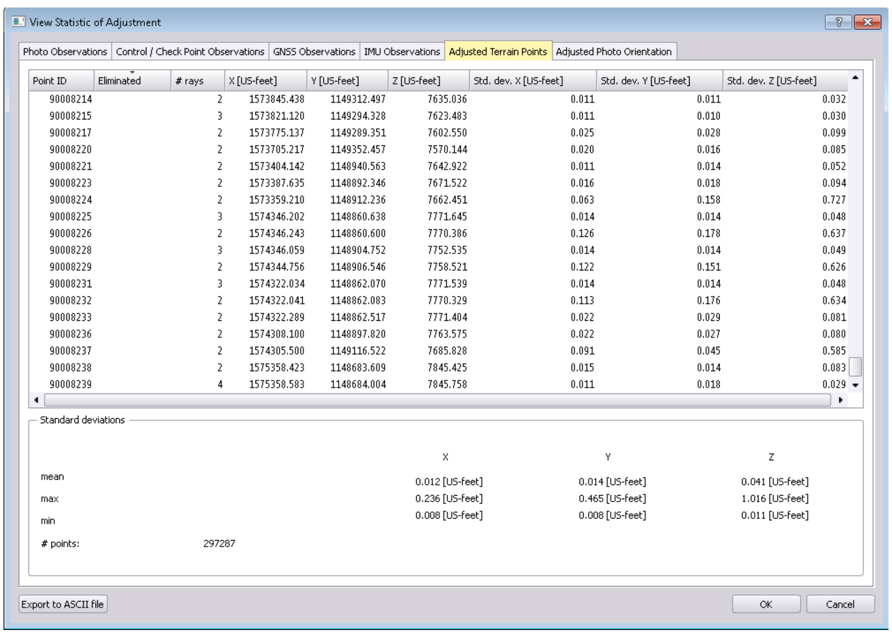
Map Accuracy RMSE: 0.5ft in X and Y
Expected AT Accuracy RMSE at control points: 0.25ft in X and Y

Bundle adjustment RMSE at control points

x	0.143 [feet]
y	0.138 [feet]
z	0.154 [feet]

Mean standard deviations of terrain points

x	0.012
y	0.014
z	0.041



Point ID	Eliminated	# rays	X [US-feet]	Y [US-feet]	Z [US-feet]	Std. dev. X [US-feet]	Std. dev. Y [US-feet]	Std. dev. Z [US-feet]
90008214		2	1573845.438	1149312.497	7635.036	0.011	0.011	0.032
90008215		3	1573821.120	1149294.328	7623.483	0.011	0.010	0.030
90008217		2	1573775.137	1149289.351	7602.550	0.025	0.028	0.099
90008220		2	1573705.217	1149352.457	7570.144	0.020	0.016	0.085
90008221		2	1573404.142	1148940.563	7642.922	0.011	0.014	0.052
90008223		2	1573387.635	1148892.346	7671.522	0.016	0.018	0.094
90008224		2	1573359.210	1148912.236	7662.451	0.063	0.158	0.727
90008225		3	1574346.202	1148860.638	7771.645	0.014	0.014	0.048
90008226		2	1574346.243	1148860.600	7770.386	0.126	0.178	0.637
90008228		3	1574346.059	1148904.752	7752.535	0.014	0.014	0.049
90008229		2	1574344.756	1148906.546	7758.521	0.122	0.151	0.626
90008231		3	1574322.034	1148862.070	7771.539	0.014	0.014	0.048
90008232		2	1574322.041	1148862.083	7770.329	0.113	0.176	0.634
90008233		2	1574322.289	1148862.517	7771.404	0.022	0.029	0.081
90008236		2	1574308.100	1148897.820	7763.575	0.022	0.027	0.080
90008237		2	1574305.500	1149116.522	7685.828	0.091	0.045	0.585
90008238		2	1575358.423	1148683.609	7845.425	0.015	0.014	0.083
90008239		4	1575358.583	1148684.004	7845.758	0.011	0.018	0.029

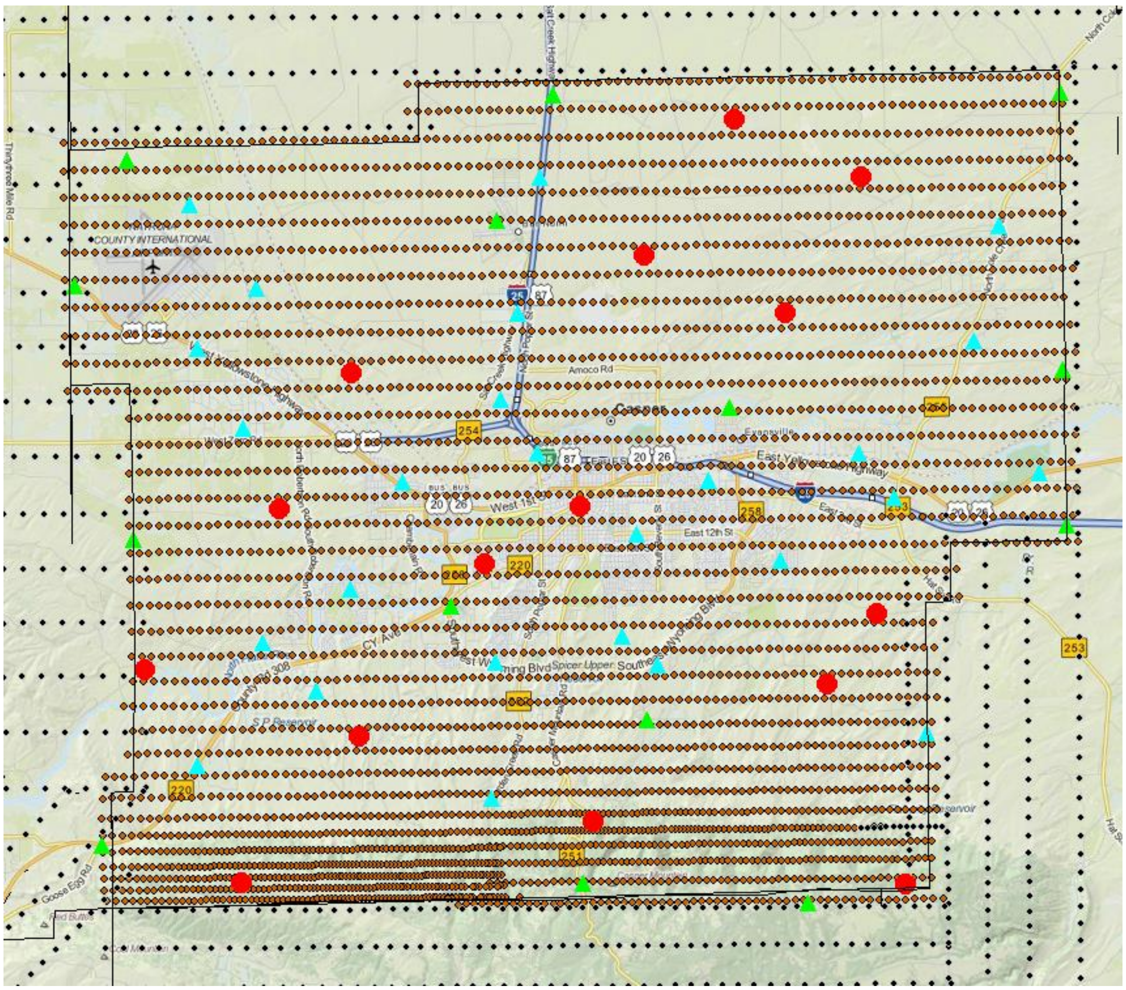
Standard deviations

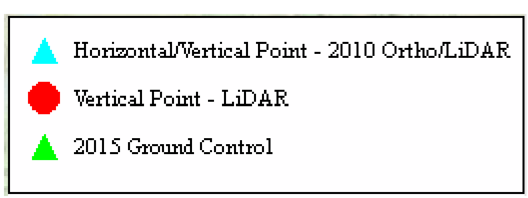
	X	Y	Z
mean	0.012 [US-feet]	0.014 [US-feet]	0.041 [US-feet]
max	0.236 [US-feet]	0.465 [US-feet]	1.016 [US-feet]
min	0.008 [US-feet]	0.008 [US-feet]	0.011 [US-feet]
# points: 297287			

1. FLIGHT/CONTROL MAP

Dates of photography: April 29 – June 12, 2015
Number of exposures: 3606 3in
Flight Height: 9000ft AMSL 3in
Image Overlap: 60% FOL / 30% SOL

Project Map





2. AIRBORNE – GPS/INS PROCESSING

The airborne-GPS data were processed using POSPac™ (version 6.2) Mobile Mapping Suite; GPS-IMU tightly coupled processing software which uses Kalman Filtering techniques, and On-The-Fly (OTF) ambiguity resolution techniques. Multiple CORS stations are being used in SmartBase trajectory processing.

2.1 SmartBase Processing Technique

Applanix SmartBase processing mode creates a virtual base station, which follows plane trajectory allowing faster and more accurate on the flight kinematic ambiguity resolution. In order to process trajectory in SmartBase processing mode multiple CORS stations (usually from 6 to 11 CORS stations per mission) are imported into the project. The network of the CORS stations creates a closed polygon around the plane trajectory. Within the polygon atmospheric corrections are well modeled and applied to each photo center. One of the most reliable CORS stations is chosen as primary station. The SmartBase quality check wrt primary is performed on all CORS stations involved in the network. Any CORS stations failing QAQC check are eliminated from processing. In the following step Applanix SmartBase CORS network adjustment is run to adjust all CORS stations to a common datum. The final step in Applanix SmartBase processing is 'GNSS-Inertial Processor' which combines GPS CORS data with inertial data in tightly coupled process. SmartBase processing creates a virtual base station, which follows plane trajectory within SmartBase region polygon. All CORS stations contribute to virtual base station accuracy.

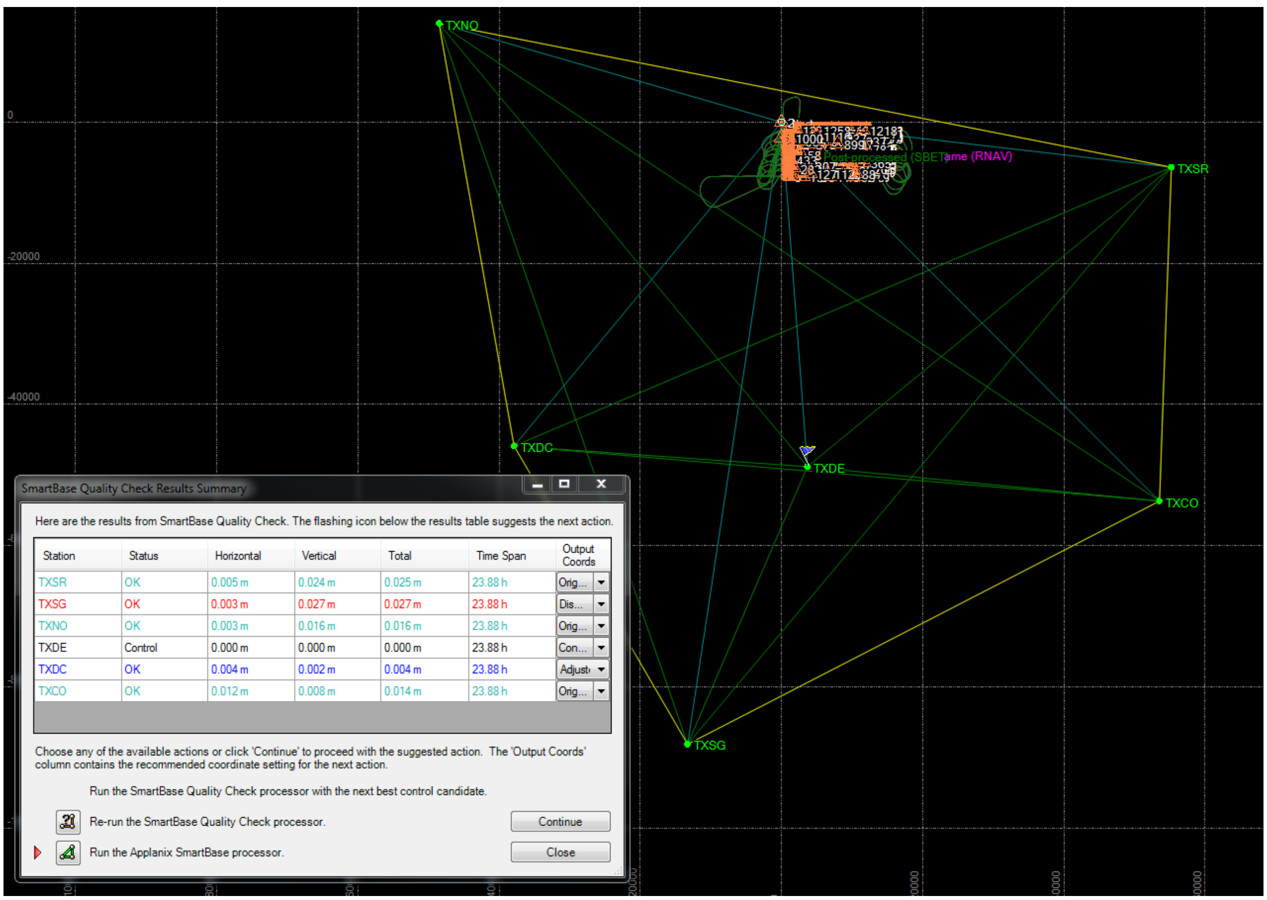
The precise position of the camera lens node was interpolated from the trajectory of GPS positions utilizing polynomial fitting techniques. The time-tag for each event served as a basis for the interpolation.

The lever arm offset values are applied to this data resulting in a final AGPS file containing the coordinates of the camera lens node at each instant of exposure. Final Exterior Orientation parameters and positions are outputted using project assigned datum, projections and units.

2.2 ABGPS Ground Reference Stations

POSPac 6.2 SmartBase processing technique requires multiple GPS ground reference stations of at least 18 hours of data to process plane trajectory. The networks of CORS stations imported into the project, created ‘SmartBase Region’ polygon for each mission. The ‘SmartBase Region’ assists in virtual base station creation and atmospheric corrections model.

CORS stations are automatically checked/QCed against one control CORS station. If a CORS station has less than 23 hours of GPS data available, or a CORS station is found to have incorrect coordinates, could be invalid or noisy observation data, this CORS station is evaluated and either automatically removed from the network of CORS stations (red) or new coordinates are recomputed (blue). See example below:



Station	Status	Horizontal	Vertical	Total	Time Span	Output Coords
TXSR	OK	0.005 m	0.024 m	0.025 m	23.88 h	Orig...
TXSG	OK	0.003 m	0.027 m	0.027 m	23.88 h	Dis...
TXNO	OK	0.003 m	0.016 m	0.016 m	23.88 h	Orig...
TXDE	Control	0.000 m	0.000 m	0.000 m	23.88 h	Con...
TXDC	OK	0.004 m	0.002 m	0.004 m	23.88 h	Adjust
TXCO	OK	0.012 m	0.008 m	0.014 m	23.88 h	Orig...

3. AERIAL TRIANGULATION

3.1 Overview

Aerial triangulation is the simultaneous space resection of image rays projected and recorded at one source, the perspective center of the aerial camera. These image rays projected from two or more overlapping images, stereo-models, intersect at the corresponding ground location to determine the three-dimensional coordinates of each point measured. This collection of image rays is fit to known ground survey control in a simultaneous 3-dimensional least squares adjustment. After the completion of this adjustment, coordinates of the 'unknown' ground points are derived by the intersection of the adjusted image points.

The purpose of aerial triangulation is to densify horizontal and vertical control from relatively few ground control points (GCPs). Since obtaining GCPs is a relatively significant expense in any mapping project, AT procedures are used to reduce the amount of field survey required by extending control to all stereo-models.

This method is essentially a mathematical tool, capable of extending control to areas between ground survey points using several contiguous uncontrolled stereo-models.

3.2 Simultaneous Adjustment by Bundles

The surveyed control, along with the reduced image coordinates, served as input into the 'combined' block adjustment. Three–dimensional, simultaneous least squares adjustments by bundles, commonly referred to as "bundle" adjustments, were undertaken using Inpho's Match-AT GPS adjustment software (v7.0). This particular bundle method is very sensitive to systematic errors of the photo measurements and provides the correction of constant and regular errors through self-calibration. This concept regards these types of errors to be common to all photographs or to be present in sub-sets of the photographs. This bundle block adjustment software has proven to be a very rigorous and stable platform.

A series of aerial triangulation solutions were completed. The adjustment strategy was devised to provide the optimal solution for the subsequent mapping, while providing comprehensive quality control to detect errors, omissions and spurious data.

3.3 Fully Constrained Adjustment

The final adjustment, and the optimal solution to be used for mapping, included all control points as constraints. All image points were assigned standard deviations of 3µm.

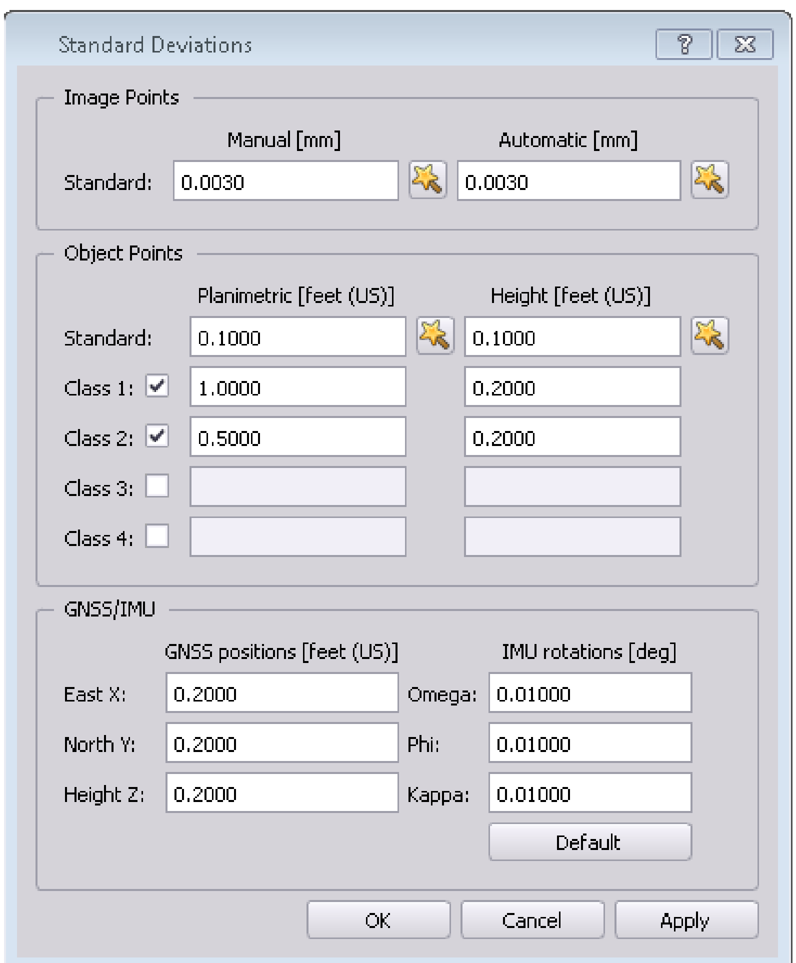
The primary control for the block adjustment was the ground control collected and processed in 2015. To ensure a good tie to the existing Casper plan and ortho dataset produced in 2010, photo identifiable points were selected, measured and used as constraints in the AT solution. In addition, elevations from the 2015 LiDAR dataset were selected and measured to ensure a good fit to the elevation datum. Performing these steps allowed for an accurate shift of the AGPS data to match the 2015 control and the 2010 datasets.

Standard Deviations were assigned as follows:

Standard = 2015 Ground Survey Control

Class 1 = 2015 LiDAR Vertical

Class 2 = 2010 Ortho Horizontal / 2015 LiDAR Vertical



3.4 AT Computed AGPS Offset

NOTE: This offset includes the average delta between the NAD83(2011) and the NAD83(1986) adjustment, but also contains offsets relative to the Applanix POSEO solution (common with all sensors and project areas). It is standard practice to perform a global shift to AGPS data during AT. Therefore, the AGPS offset will not match the ground survey computed offset between 2011 and 1986.

```
Residuals GNSS observations in [feet]

               photo ID                rx                 ry                 rz


          GNSS drift parameter for profile 1
          constant part in [feet]   X     -1.475   Y      1.674   Z     -1.133
          linear   part in [feet]   X     -0.000   Y      0.000   Z      0.000
```

3.5 Project Ground Control

Project information		Coordinate System	
Name:		Name:	US State Plane 1983
Size:	1 MB	Datum:	NAD 1983 - 1986
Modified:	12/22/2015 1:26:20 PM (UTC:-7)	Zone:	Wyoming East Central 4902
Time zone:	Mountain Standard Time	Geoid:	GEOID12A (Conus)
Reference number:		Vertical datum:	NAVD88
Description:			

Point List

ID	Easting (US survey foot)	Northing (US survey foot)	Elevation (US survey foot)	Feature Code
AA2138	1591863.241	1173140.551	5614.485	
CAS301	1542268.236	1215522.776	5371.470	
CAS302	1580570.299	1221423.222	5305.853	
CAS303	1626181.723	1221736.373	5487.749	
CAS304	1626439.923	1196787.204	5277.064	
CAS305	1626795.846	1182731.465	5162.408	
CAS306	1589040.312	1165250.855	5771.178	
CAS307	1603578.651	1148762.190	7786.877	
CAS308	1583358.606	1150568.722	7528.350	
CAS309	1540077.049	1153888.427	5374.016	
CAS310	1542834.215	1181484.307	5369.459	
CAS311	1537553.325	1204321.365	5313.733	
CAS312	1596433.322	1193344.550	5105.520	
CAS313	1571394.252	1175410.945	5190.273	
CAS314	1575545.070	1210195.169	5305.681	
CAS615	1594887.838	1390057.847	4871.214	
CAS616	1599723.957	1356367.313	5065.305	
CAS617	1579423.887	1298584.067	5417.239	
CAS619	1628993.870	1278005.303	5821.151	
CAS620	1616348.794	1252387.560	5465.062	
CAS621	1578516.045	1277182.466	5609.875	
CAS622	1602136.937	1263707.691	5552.162	
CAS623	1580172.208	1236774.969	5334.849	

CAS624	1532007.961	1249466.299	5331.657	
CAS625	1473483.101	1242921.496	5550.813	
CAS626	1514746.298	1176982.237	5360.140	
CAS627	1488046.693	1228704.160	5556.939	
CAS628	1395921.955	1251700.980	5668.344	
CAS629	1348094.488	1266417.213	6055.036	
CAS630	1308571.118	1280499.815	5998.923	
CAS631	1452436.838	1250321.173	5607.779	
CAS632	1634170.316	1132397.387	5709.589	
CAS633	1538916.870	1130390.193	5580.709	
CAS634	1510625.852	1131204.119	5250.027	
CAS635	1459115.580	1070473.937	5629.992	
CAS636	1474269.759	1060107.644	5669.554	
CAS637	1482573.815	1087232.335	5451.739	
CASPER_APT	1546702.070	1203797.900	5322.245	
CP101A	1307812.542	1281368.651	6006.738	
CP102A	1310860.911	1277678.448	6011.125	
CP103A	1313159.094	1275060.688	6093.766	
CP104A	1347103.170	1258926.828	5956.763	
CP105A	1355365.421	1263568.117	6080.729	
CP106A	1349101.087	1264769.390	6044.746	
CP107A	1373555.909	1258262.775	6076.610	
CP108A	1382744.027	1253671.413	5960.222	
CP109A	1376718.270	1255994.614	6040.081	
CP110A	1396966.486	1254095.255	5730.631	
CP111A	1406459.366	1250793.550	5704.706	
CP112A	1400175.689	1250967.510	5726.259	
CP113A	1405217.343	1252351.219	5720.200	
CP114A	1602635.838	1397642.580	5070.327	
CP115A	1596370.605	1380050.854	4953.000	
CP116A	1648151.939	1193724.953	5050.636	
CP117A	1521306.773	1120096.449	5419.374	
CP118A	1506226.237	1095356.406	5284.611	
CP119A	1588879.724	1397876.775	4795.172	
CP120A	1544925.302	1128970.431	5788.427	
NR0223	1538309.736	1203782.876	5305.621	
NR0224	1544098.467	1200112.006	5311.087	
WYRF	1582177.215	1178911.188	5404.855	

3.5.1 2010 Ortho/LiDAR Control Coordinates (3in and 6in blocks)

The following ‘control’ points were derived by extracting coordinate values from 2010 orthos and 2015 LiDAR. Note: Most of the points were able to be transferred, but not all points were used in the AT of the 3in and 6in blocks as the transfer confidence was low due to temporal changes between 2010 and 2015. NOTE: These are NOT surveyed points, and should not be considered as such.

Identifier	Source	Use
2010HV	2010 Orthos	3in and overlapping 6in Imagery
2010V	2015 LiDAR	3in and overlapping 6in Imagery
NE_las	2015 LiDAR	Northeast PILOT
NE_Ortho	2010 Orthos	3in PILOT
sw_las	2015 LiDAR	6in PILOT

Point	X	Y	Z
2010HV_01	1547869.03	1211577.41	5295.57
2010HV_02	1620712.52	1209646.97	5353.11
2010HV_03	1577466.87	1201852.52	5258.46
2010HV_04	1548663.25	1198636.37	5259.58
2010HV_05	1624401.86	1187464.01	5107.25
2010HV_06	1611339.88	1185186.62	5162.44
2010HV_07	1579243.38	1189256.10	5170.40
2010HV_08	1601027.60	1179573.26	5297.81
2010HV_09	1614269.14	1164031.93	5552.28
2010HV_10	1575026.91	1158144.81	6073.35
2010HV_11	1548572.34	1161154.01	5371.52
2010HV_12	1559322.57	1167788.84	5265.44
2010HV_13	1552721.51	1191452.46	5283.16
2010HV_14	1588173.25	1181971.91	5250.01
2010HV_15	1562373.79	1176977.23	5142.16
2010HV_16	1586782.63	1172800.92	5375.01
2010HV_17	1575428.86	1170346.65	5432.84
2010HV_18	1567066.34	1186601.49	5186.18
2010HV_19	1608150.57	1189237.75	5113.80
2010HV_20	1579389.99	1213994.62	5347.74
2010HV_21	1618488.47	1199386.24	5216.21
2010HV_22	1554524.04	1172211.21	5201.36
2010HV_23	1553924.15	1203985.35	5248.70
2010HV_24	1575937.67	1194009.86	5356.41
2010HV_25	1590009.41	1170117.64	5679.02
2010HV_26	1594639.87	1186747.58	5156.30

2010HV_27	1579385.79	1165987.47	5683.63
2010HV_28	1577801.15	1163986.33	5618.34
2010V_01	1596995.46	1219212.60	5373.43
2010V_02	1608323.33	1214086.75	5349.35
2010V_03	1588801.40	1207011.07	5278.79
2010V_04	1601480.80	1201758.00	5142.94
2010V_05	1562512.22	1196347.28	5174.76
2010V_06	1543959.17	1169654.34	5197.89
2010V_07	1552645.09	1150550.79	7257.39
2010V_08	1563224.41	1163641.19	5519.25
2010V_09	1584198.71	1156057.69	6747.33
2010V_10	1574450.35	1179277.68	5132.32
2010V_11	1609712.50	1174723.98	5362.17
2010V_12	1612331.80	1150428.73	7530.80
2010V_13	1605353.61	1168407.08	5528.60
2010V_14	1556046.74	1184204.01	5227.11
2010V_15	1583094.38	1184396.70	5125.55
NE_las10	1600230.69	1182104.69	5301.31
NE_las11	1605658.76	1192290.77	5109.20
NE_las6	1600190.68	1194855.61	5155.38
NE_las7	1609528.05	1189708.55	5112.53
NE_las8	1600978.26	1186845.80	5175.82
NE_las9	1609302.72	1182415.76	5213.88
NE_Ortho1	1600106.32	1194748.48	5154.80
NE_Ortho2	1608150.59	1189237.86	5114.74
NE_Ortho3	1601095.68	1187007.70	5165.18
NE_Ortho4	1607701.48	1184319.74	5248.02
NE_Ortho5	1600876.26	1181958.23	5274.85
NE_Ortho6	1609696.06	1191525.34	5099.71
sw_las1	1526339.48	1159157.96	5230.36
sw_las2	1531500.22	1154654.98	5193.08
sw_las3	1527754.06	1150090.73	5222.80
sw_las4	1529598.12	1145731.57	5279.19
sw_las5	1532376.41	1158956.19	5189.29
sw_las6	1533774.28	1152437.52	5275.62
sw_las7	1525345.55	1154208.16	5202.63

3.6 Summary of AT Results – 3in Block

```
Total of 1195970 measurements in 3606 photos are used for adjustment

  found      59968 points connecting   2 photos
  found      87310 points connecting   3 photos
  found      56785 points connecting   4 photos
  found      58855 points connecting   5 photos
  found      43700 points connecting   6 photos
  found       2863 points connecting   7 photos
  found        826 points connecting   8 photos
  found        380 points connecting   9 photos
  found         24 points connecting  10 photos
  found         12 points connecting  11 photos
  found          4 points connecting  12 photos

  number of observations     2413729
  number of unknowns          953835
  redundancy                 1459894

  RMS automatic points in photo (number: 1195684)
          x           0.4 micron
          y           0.4 micron

  RMS   control and manual points in photo (number: 286)
          x           3.0 micron
          y           2.3 micron

  RMS control points with default standard deviation set (number: 14)
          x         0.143 [feet]
          y         0.138 [feet]

  RMS control points  with default standard deviation set (number: 14)
          z         0.154 [feet]

  RMS control points with standard deviation set  1 (number: 6)
          z         0.231 [feet]

  RMS control points with standard deviation set  2 (number: 30)
          x         0.455 [feet]
          y         0.516 [feet]

  RMS control points with standard deviation set  2 (number: 45)
          z         0.199 [feet]

  RMS IMU observations (number: 3606)
          omega     0.007 [deg]
          phi       0.010 [deg]
          kappa     0.021 [deg]

  RMS GNSS observations (number: 3606)
          x         0.237 [feet]
          y         0.130 [feet]
          z         0.090 [feet]
```

sigma naught 0.7 micron (11:51:31)

3.7 Ground Control Residuals – 3in Block

residuals horizontal control points in [feet]

control point ID	rx	ry
CAS301	0.138	-0.189
CAS302	0.197	0.022
CAS303	0.356	0.220
CAS304	0.060	0.087
CAS305	0.080	-0.087
CAS306	-0.149	-0.101
CAS307	-0.149	-0.039
CAS308	-0.187	0.051
CAS309	-0.059	0.086
CAS310	-0.077	-0.187
CAS311	0.024	-0.297
CAS312	-0.038	-0.042
CAS313	-0.032	-0.041
CAS314	-0.000	-0.134
2010HV_01	0.194	-0.502
2010HV_03	-1.561	-0.428
2010HV_05	0.209	0.694
2010HV_06	0.208	0.164
2010HV_07	-0.642	0.164
2010HV_08	-0.727	1.059
2010HV_13	-0.484	-0.612
2010HV_14	-0.289	0.825
2010HV_15	-0.336	1.003
2010HV_16	0.069	0.439
2010HV_18	0.162	-0.299
2010HV_20	-0.660	-0.575
2010HV_21	0.677	-0.002
2010HV_22	0.018	0.265
2010HV_23	0.604	0.364
2010HV_24	-1.021	0.224
2010HV_26	-0.336	0.178
2010HV_27	0.187	1.008
2010HV_28	-0.490	1.342
NE_Ortho1	-0.235	0.033
NE_Ortho2	-0.376	0.391
NE_Ortho3	-0.125	0.461
NE_Ortho4	0.253	0.780
NE_Ortho5	-0.441	0.895
NE_Ortho6	0.674	0.451

residuals vertical control points in [feet]

control point ID	rz
CAS301	0.212
CAS302	0.264
CAS303	0.412
CAS304	0.204
CAS305	0.014
CAS306	-0.029
CAS307	-0.002
CAS308	-0.032
CAS309	0.006
CAS310	-0.029
CAS311	0.065
CAS312	0.007
CAS313	0.012
CAS314	0.019
NE_las6	-0.017
NE_las7	0.083
NE_las8	0.048
NE_las9	0.129
2010V_01	0.108
2010V_02	0.405
2010V_03	0.418
2010V_04	0.376
2010V_05	-0.176
2010V_06	-0.084
2010V_07	-0.354
2010V_08	-0.028
2010V_09	-0.347
2010V_10	-0.299
2010V_11	-0.042
2010V_12	-0.009
2010V_13	-0.249
2010V_14	0.071
2010V_15	-0.252
NE_las10	-0.283
NE_las11	0.462
2010HV_01	-0.029
2010HV_03	0.239
2010HV_04	-0.074
2010HV_05	-0.247
2010HV_06	-0.059
2010HV_07	0.043
2010HV_08	0.036
2010HV_09	0.193
2010HV_10	0.012
2010HV_13	-0.044
2010HV_14	-0.024
2010HV_15	-0.340
2010HV_16	-0.004
2010HV_17	-0.167
2010HV_18	-0.114
2010HV_20	0.060
2010HV_21	-0.200
2010HV_22	0.023
2010HV_23	-0.068
2010HV_24	-0.083
2010HV_25	-0.157
2010HV_26	-0.183
2010HV_27	-0.205
2010HV_28	-0.199
NE_Ortho1	0.011

NE_Ortho2	0.289
NE_Ortho3	0.305
NE_Ortho4	-0.045
NE_Ortho5	-0.023
NE_Ortho6	0.289

3.8 Ground Control Checkpoint Residuals – 3in Block

To check the accuracy of the AT solution, three (3) points within the center of the AT block were withheld (unweighted) from the solution. The results are below, and indicate the solution is within the accuracy specifications for 1”=50’ scale mapping.

RMS at check points

x	0.069 [feet]	(number: 3)
y	0.084 [feet]	(number: 3)
z	0.274 [feet]	(number: 3)

residuals horizontal check points in [feet]

control point ID	rx	ry	
CAS312	-0.082	-0.001	check point
CAS313	-0.061	0.013	check point
CAS314	-0.062	-0.144	check point

APPENDIX A – CAMERA CALIBRATION REPORT

UltraCamX, Serial Number UCX-SX-1-60418665

Calibration Report

Short Version

Camera:	**UltraCam X, S/N UCX-SX-1-60418665**
Manufacturer:	**Vexcel Imaging GmbH, A-8010 Graz, Austria**
Date of Calibration:	**Apr-17-2014**
Date of Report:	**May-07-2014**
Camera Revision:	**7.0**
Revision of Report:	**7.0**

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Panchromatic Camera

Large Format Panchromatic Output Image

Image Format	long track	67.824mm	9420pixel
	cross track	103.896mm	14430pixel
Image Extent		(-33.91, -51.95)mm	(33.91, 51.95)mm
Pixel Size		7.200µm*7.200µm	
Focal Length	ck	100.500mm	± 0.002mm
Principal Point	X_ppa	0.000 mm	± 0.002mm
(Level 2)	Y_ppa	0.144 mm	± 0.002mm
Lens Distortion	Remaining Distortion less than 0.002mm		

Multispectral Camera

Medium Format Multispectral Output Image
(Upscaled to panchromatic image format)

Image Format	long track	67.824mm	3140pixel
	cross track	103.896mm	4810pixel
Image Extent		(-33.91, -51.95)mm	(33.91, 51.95)mm
Pixel Size		21.600µm*21.600µm	
Focal Length	ck	100.500mm	
Principal Point	X_ppa	0.000 mm	± 0.002mm
(Level 2)	Y_ppa	0.144 mm	± 0.002mm
Lens Distortion	Remaining Distortion less than 0.002mm		

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VEXCEL IMAGING
a Microsoft company

Calibration Report

Summary

Camera:	**UltraCam X, S/N UCX-SX-1-60418665**
Manufacturer:	**Vexcel Imaging GmbH, A-8010 Graz, Austria**
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Revision of Report:	**7.0**

The following calibrations have been performed for the above mentioned digital aerial mapping camera:

- Geometric Calibration
- Verification of Lens Quality and Sensor Adjustment
- Radiometric Calibration
- Calibration of Defective Pixel Elements
- Shutter Calibration
- Sensor and Electronics Calibration

This equipment is operating fully within specification as defined by Vexcel Imaging GmbH.

Dr. Michael Gruber
Chief Scientist, Photogrammetry
Vexcel Imaging GmbH

Ing. Peter Prassl
Senior Calibration Engineer
Vexcel Imaging GmbH

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