Project Report Appendices

The following section contains the appendices as listed in the Allentown, PA 2016 LiDAR and Orthoimagery Project Report.

Appendix A

Camera Calibration Report

Camera Calibration Certificate
No: DMC IIe 230 – 23522

For

Richard Crouse & Associates

467 Aviation Way
Frederick, MD 21701

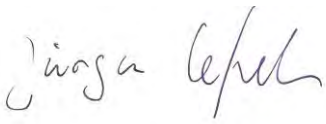
USA

Camera:	DMC IIe 230
Manufacturer:	Z/I Imaging GmbH, D-73431 Aalen, Germany
Reference:	PAN
Serial Number:	00123118 (PAN Head)
Date of Calibration:	20. November 2014
Date of Report:	26. November 2014
Number of Pages:	43

Calibration performed at: Carl Zeiss Jena, Carl-Zeiss-Promenade 10, 07745 Jena, Germany.

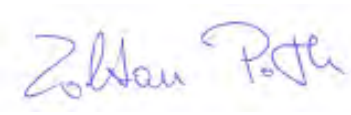
This camera system is certified by Z/I Imaging and is fully functional within its specifications and tolerances.

Date of Calibration: November 2014



Jürgen Hefele, Senior Software Developer

Date of Certification: November 2014



Dipl.Ing. Zoltan Poth, Workflow Support Engineer

Camera Serial Numbers and Burn-In flight

Camera Head	Serial Number	Calib. Date
PAN (reference)	00123118	20.11.2014
MS1 (NIR)	00118804	20.11.2014
MS2 (Blue)	00124736	20.11.2014
MS3 (Red)	00124693	20.11.2014
MS4 (Green)	00124739	20.11.2014

Burn-In flight performed: 03. October 2014

Test block configuration

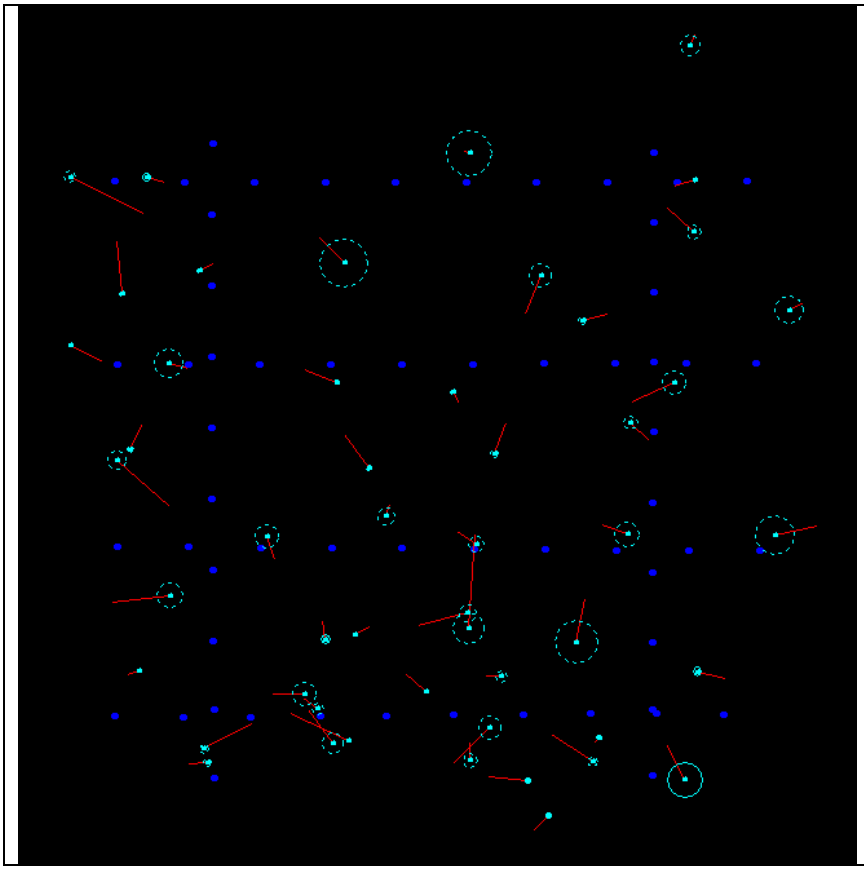
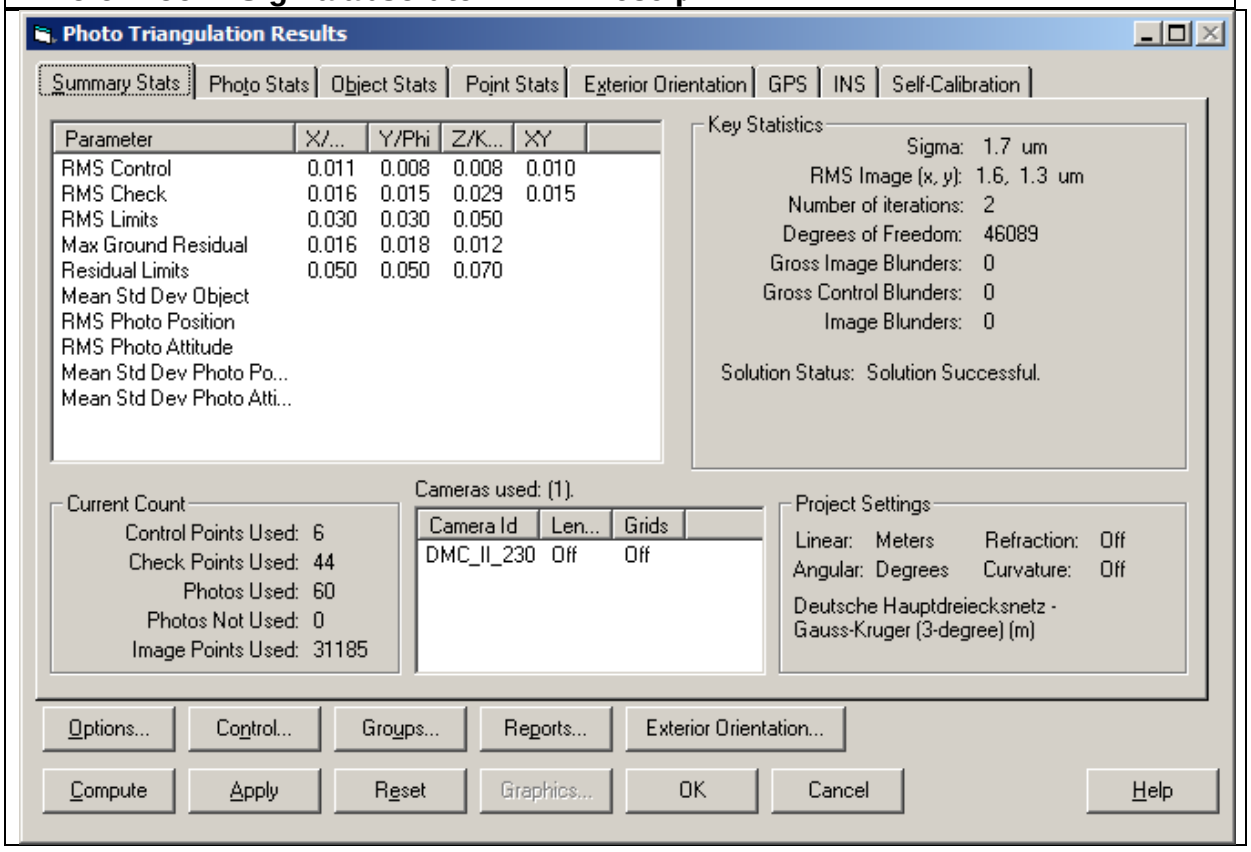


Photo Scale	1:9239.1
Flying Height [m]	850 AGL
Flying Altitude [m]	1300 AMSL
Run-Spacing [m]	419.2
Base-Length [m]	210.2
Number of Exposures	55
Side-lap [%]	70
End-lap [%]	50
Terrain Height [m]	450
Number of strips	6
Photos in one strip	2 x 9 N-S 4 x 9 W-E
Photos Used	60
Control Points Used	6
Check Points Used	44
GSD [cm]	5

Aerial triangulation statistic results:

Whole Block	**Sigma relative :**	**1.903 µm**
Whole Block	**Sigma absolute :**	**1.689 µm**



The results of the aerial triangulation were generated with ImageStation Automatic Triangulation (ISAT), Version 2014, from Intergraph Z/I Imaging. The maximum RMS in check points is ≤ 0.5 GSD in x,y and ≤ 0.7 GSD in z.

Aerial Triangulation performed by Zoltan Poth

Dipl. Ing. Z. Poth

26.11.2014
Date

Geometric Calibration

The output image geometry is based on the Pan Camera head (reference head = master camera). All other camera heads are registered and aligned to this head. Aerial triangulation checks overall system performance based on.

Output image

Reference Camera	PAN	
Serial Number	00123118	
Number of rows/columns [pixels]	15552 x 14144	
Pixel Size [μm]	5.600 x 5.600	
Image Size [mm]	87.0912 x 79.2064	
Focal Length [mm]	92.0064 mm	+ /- 0.002 mm
Principal Point [mm]	X= 0.0005 mm Y= -0.0032 mm	+ /- 0.002 mm

The geometric calibration takes place at Carl Zeiss Jena on a certified test stand. More than 800 “light targets”, projected on 28 lines that are distributed diagonally on the focal plane, are automatically measured by finding their centers light with a precision of less than 1/10 of a pixel. The light targets are projected from the “infinity” by using a collimator (Figure 1).

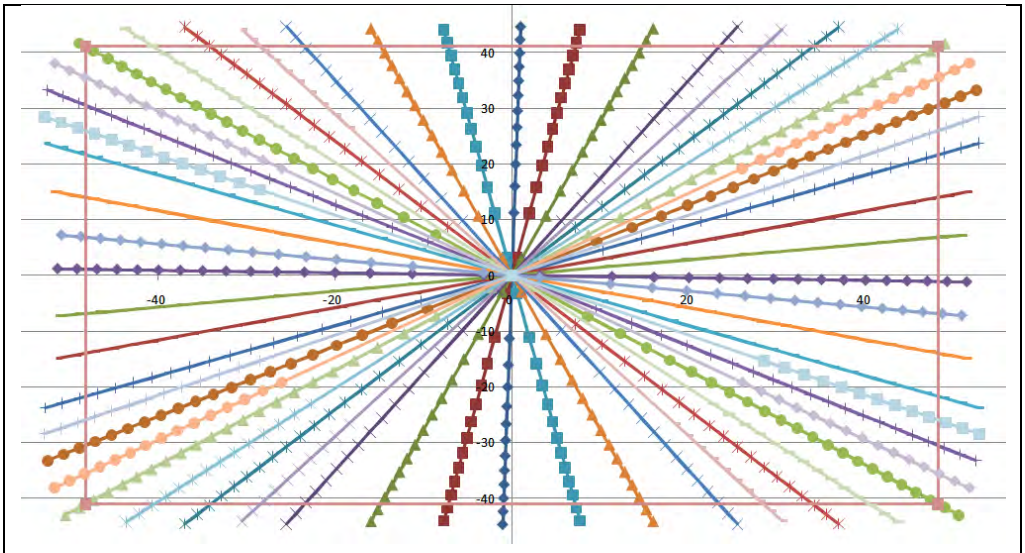


Figure 1: Light Target Pattern by Collimator

Geometric Calibration

Image Residuals

Figure 2 shows the image residuals, split in radial and tangential directions after the calibration adjustment. The maximum residuals are less than or equal to 1.5 microns and the RMSE values are below 0.5 microns.

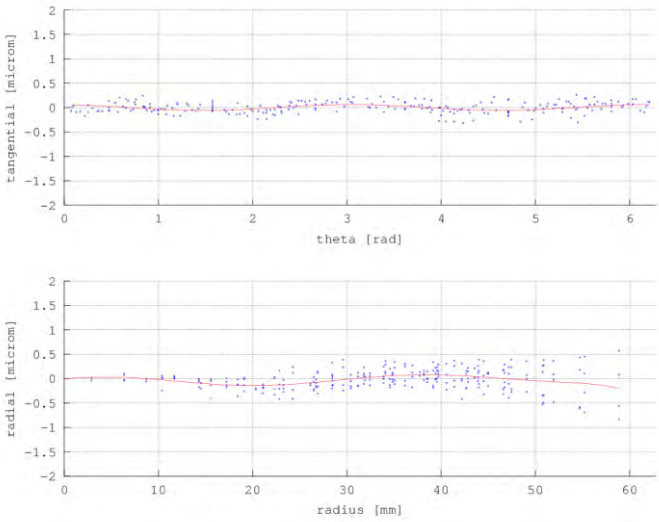


Figure 2: Tangential/Radial Distortion Residuals

Figure 3 shows the 2-D plot of the image residuals in mm.

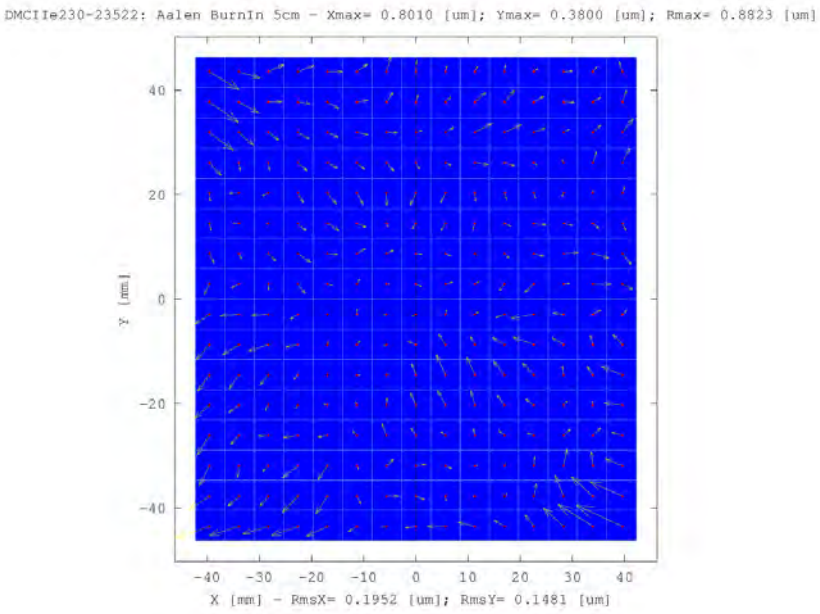


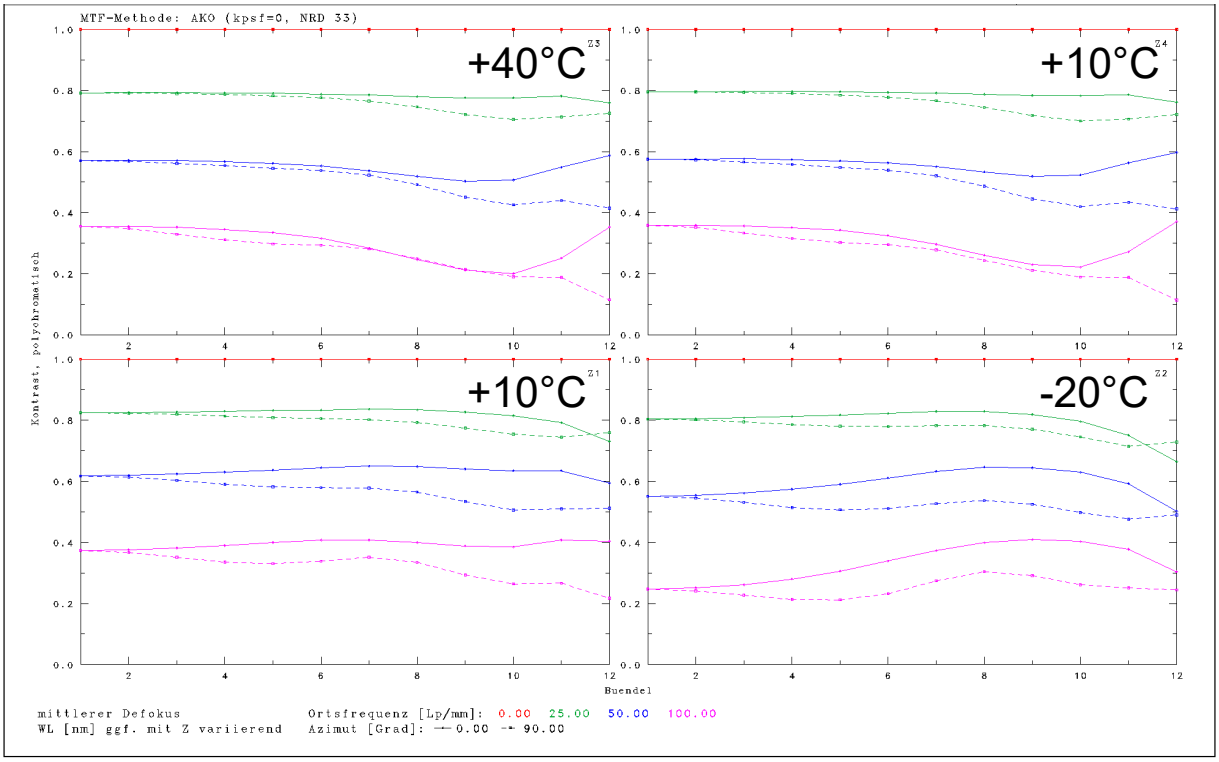
Figure 3: 2-D Image Residuals.

RMS < 0.20 um (maximum 0.88 microns)

Optical System

Modulation Transfer Function, MTF of PAN Camera (Reference)

DMC IIe PAN – MTF Polychromatic F/5.6 ; 92 mm – Temperature Stability

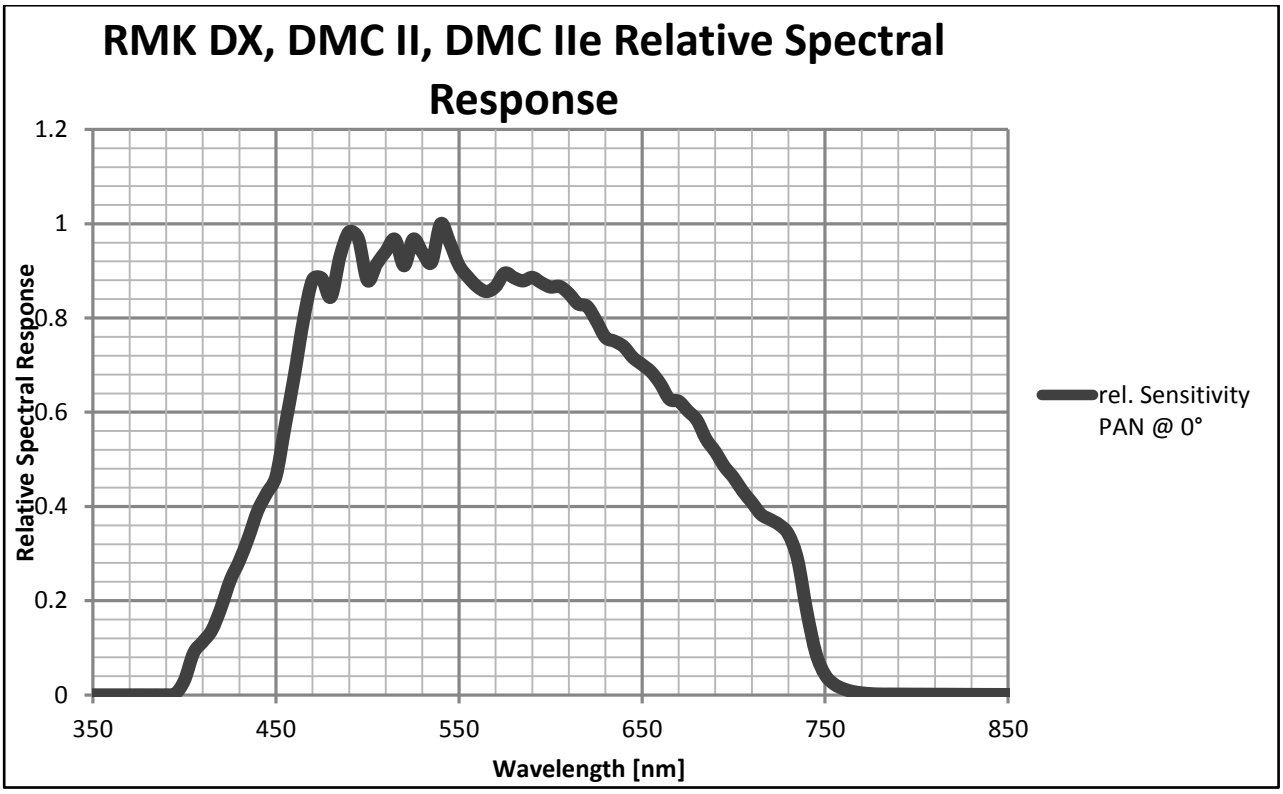


The MTF measurement is camera type specific and shows variation of the MTF within the specified temperature range.

This is a camera type specific measurement.

Radiometric Calibration

Sensitivity of PAN camera (Reference)



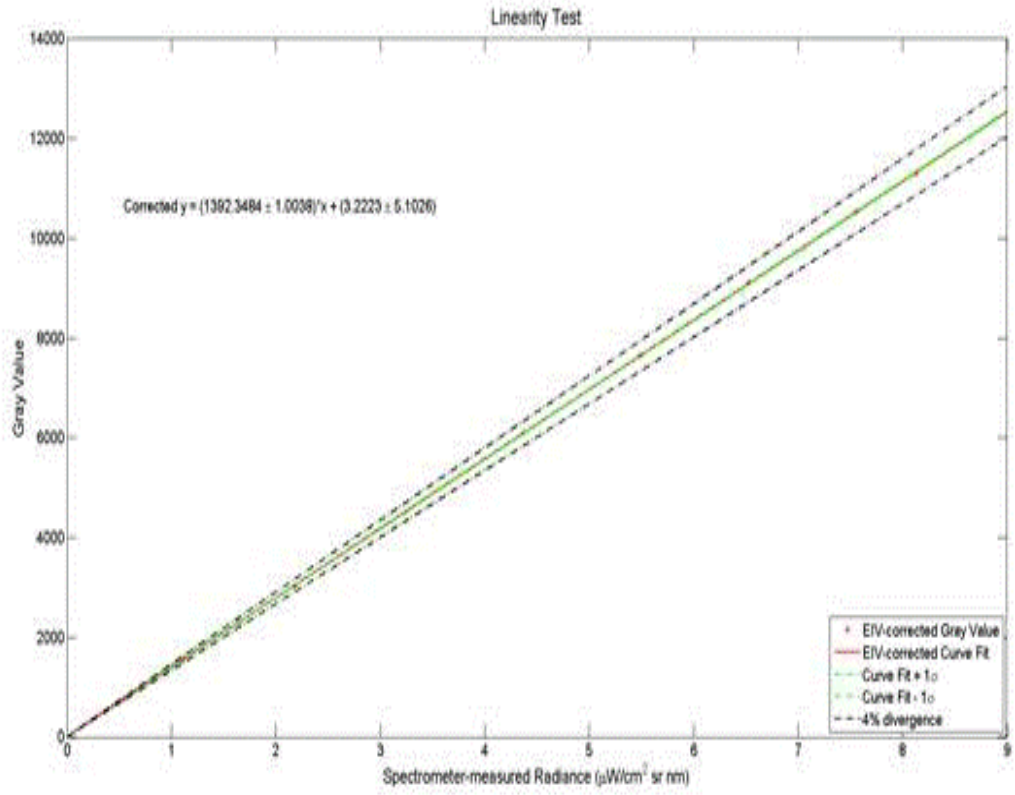
The sensitivity shows the spectral response curve of the single camera head including the optical system (optics, filter) and the sensor response. The DMC IIe 250 is calibrated with respect to the absolute spectrometer. This allows computing pixel radiance values from pixels digital numbers and is a camera type specific calibration.

This is a camera type specific measurement.

Radiometric Calibration

Sensor Linearity (Reference)

The sensor linearity is measured in the Lab with calibrated spectrometer. This is a camera type specific calibration.
Below figure shows the linearity of the raw sensor and after flat fielding:



Senor Linearity

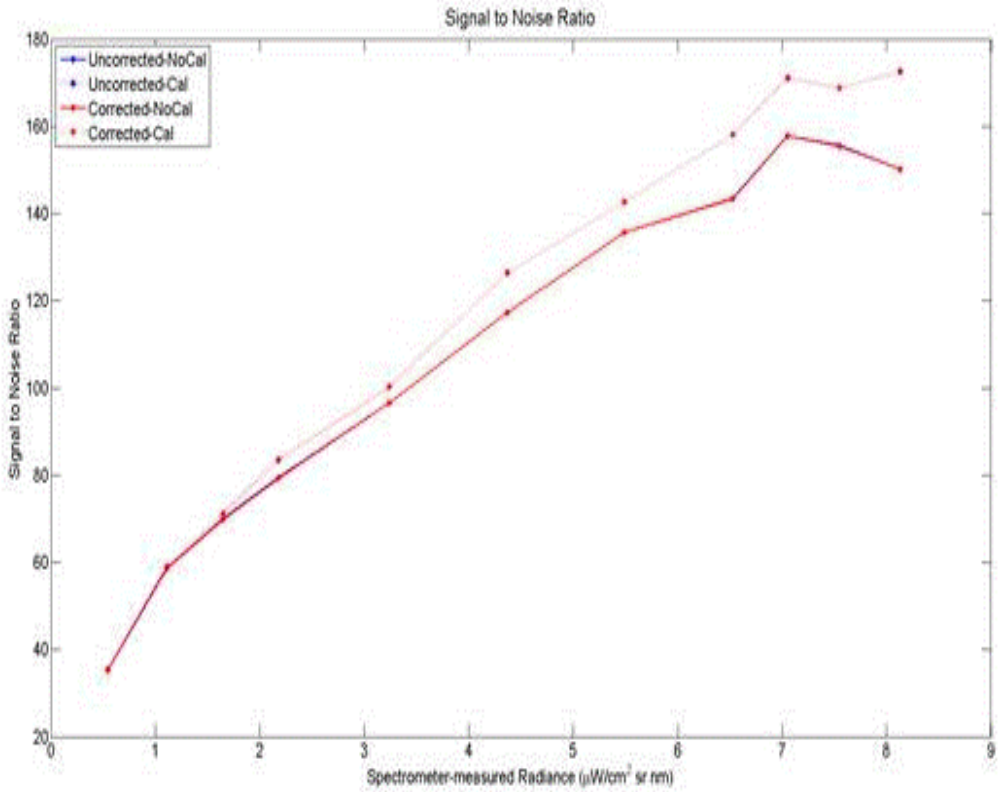
The deviation from the linearity is below 1%.

This is a camera type specific measurement.

Radiometric Calibration

Sensor Noise (Reference)

Sensor noise shows image noise with respect to the image center measured at an aperture of 16 with exposure time of 16msec.



Sensor Signal to Noise Ratio

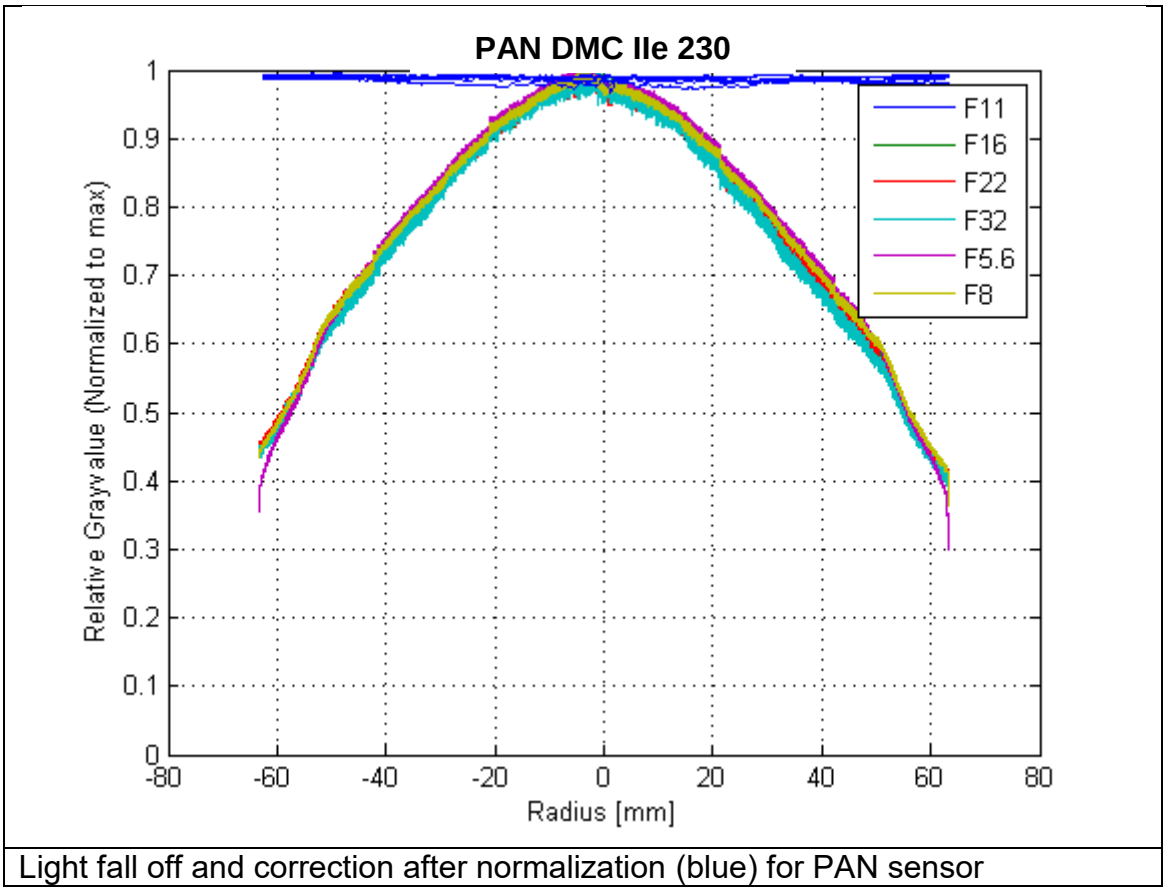
This is from a camera type specific calibration.

Radiometric Calibration

Aperture Correction (Reference)

Camera PAN (00123118)

The light fall off to the border due the influence of the optics depends on the aperture used. Therefore this calibration approach delivers individual calibration images for each aperture (Full F-Stop). In general the light fall off is a function of the image height (radial distance from center). The figure below shows the profile from the upper left corner to the lower right corner of the calibration images. Compensation of the light fall off can be measured after normalization and is within ± 2.5% of the dynamic range.



Light fall off and correction after normalization (blue) for PAN sensor

This is from a camera type specific calibration.

Radiometric Calibration

Defect Pixel

Camera PAN (00123118)

Defect pixels are detected during radiometric calibration and will be corrected during radiometric processing of the images. The quantity and cumulative percentage and specification of defects is described in Appendix “Defect Pixel Recognition”.

Revision of calibration:	131073
CCDRevision:	1
Date Number:	1407315066
Date:	140806
Number of defect pixels:	118
Number of defect clusters:	0
Number of defect columns:	0

Nr	Row	Column
0	2159	93
1	2158	94
2	2159	94
3	2157	95
4	2158	95
5	2156	96
6	2157	96
7	2157	97
8	12217	131
9	12218	131
10	12219	131
11	12220	131
12	12217	132
13	12221	132
14	12217	133
15	12219	133
16	12221	133
17	12218	134
18	12219	134
19	12220	134
20	4621	193
21	12908	250
22	5697	293
23	11154	751
24	11155	751
25	11154	752
26	11155	752
27	11156	752
28	11157	752
29	11154	753
30	11155	753
31	11156	753
32	11157	753
33	11154	754
34	11155	754
35	11156	754
36	11157	754
37	11154	755
38	11155	755
39	11156	755
40	11154	756
41	11155	756
42	11154	757
43	11155	757
44	11156	758

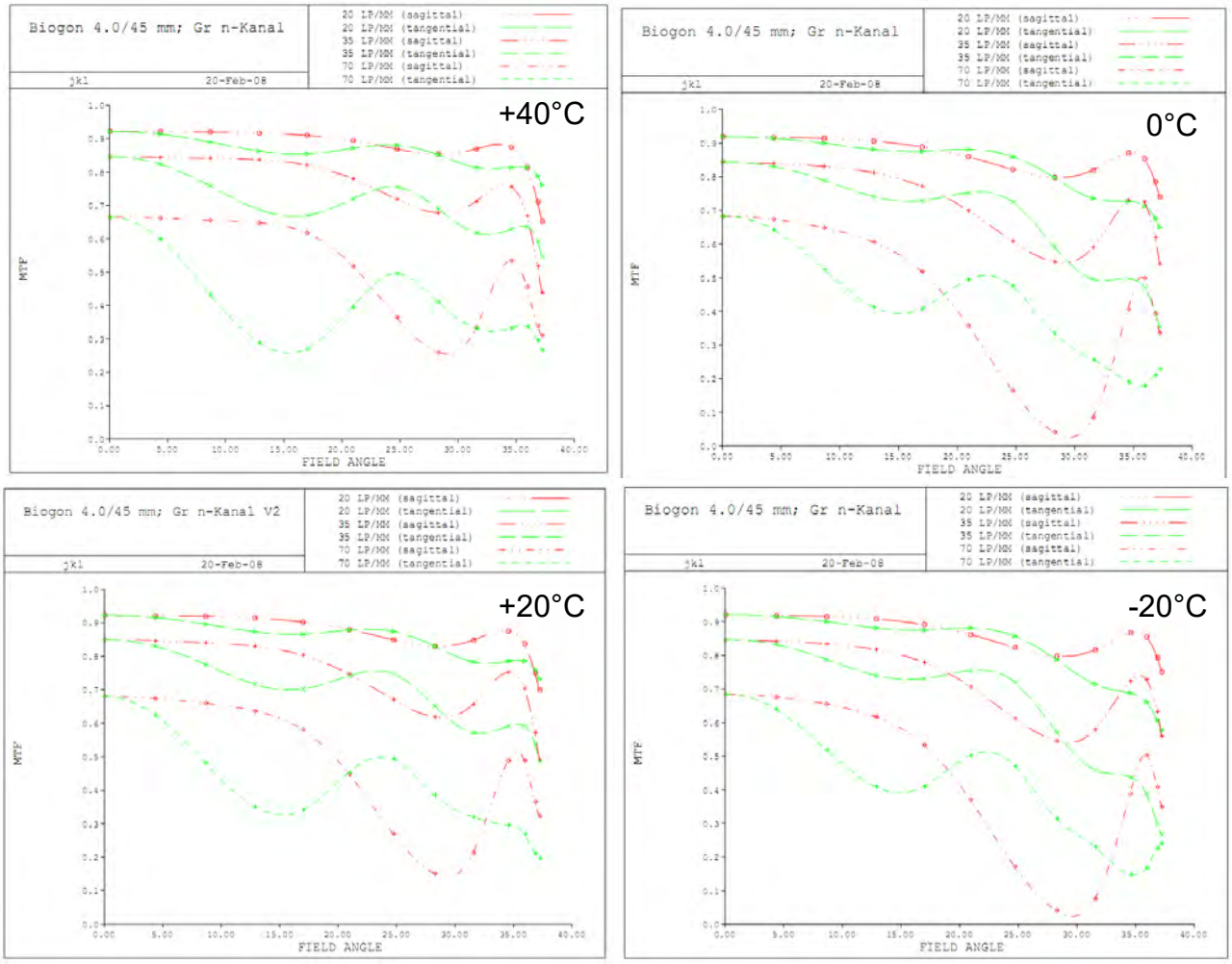
45	9279	1269
46	5123	2255
47	5124	2255
48	5122	2256
49	5123	2256
50	5124	2256
51	5122	2257
52	5123	2257
53	5122	2258
54	4836	2639
55	7969	2678
56	68	3448
57	10630	3934
58	13817	4119
59	10453	5815
60	10455	5816
61	10452	5817
62	10455	5818
63	8091	7649
64	1181	8221
65	13832	8952
66	13832	8953
67	1927	9003
68	4099	9385
69	1795	9839
70	13968	10057
71	7581	10337
72	3857	11219
73	3857	11220
74	9	12030
75	10078	12177
76	284	12529
77	285	12529
78	284	12530
79	285	12530
80	12861	12642
81	720	12813
82	721	12813
83	718	12814
84	1764	13207
85	1766	13207
86	1763	13208
87	1764	13208
88	1765	13208
89	1766	13208
90	1763	13209
91	1764	13209
92	1765	13209
93	3946	13948
94	1468	14431
95	6574	15166
96	2366	15352
97	2366	15353
98	5173	15447
99	3110	15461
100	11876	15652
101	11876	15653
102	11876	15654
103	11875	15655
104	11875	15656
105	5	16119
106	25	16207
107	25	16208
108	594	16442
109	12112	16711
110	13160	16972
111	13604	16981
112	13605	16981
113	13605	16982
114	5025	17151
115	5025	17152
116	10037	17182
117	10036	17183

Defect Column RowStart ColumnStart RowEnd ColumnEnd

Optical System

Modulation Transfer Function, MTF of Green camera

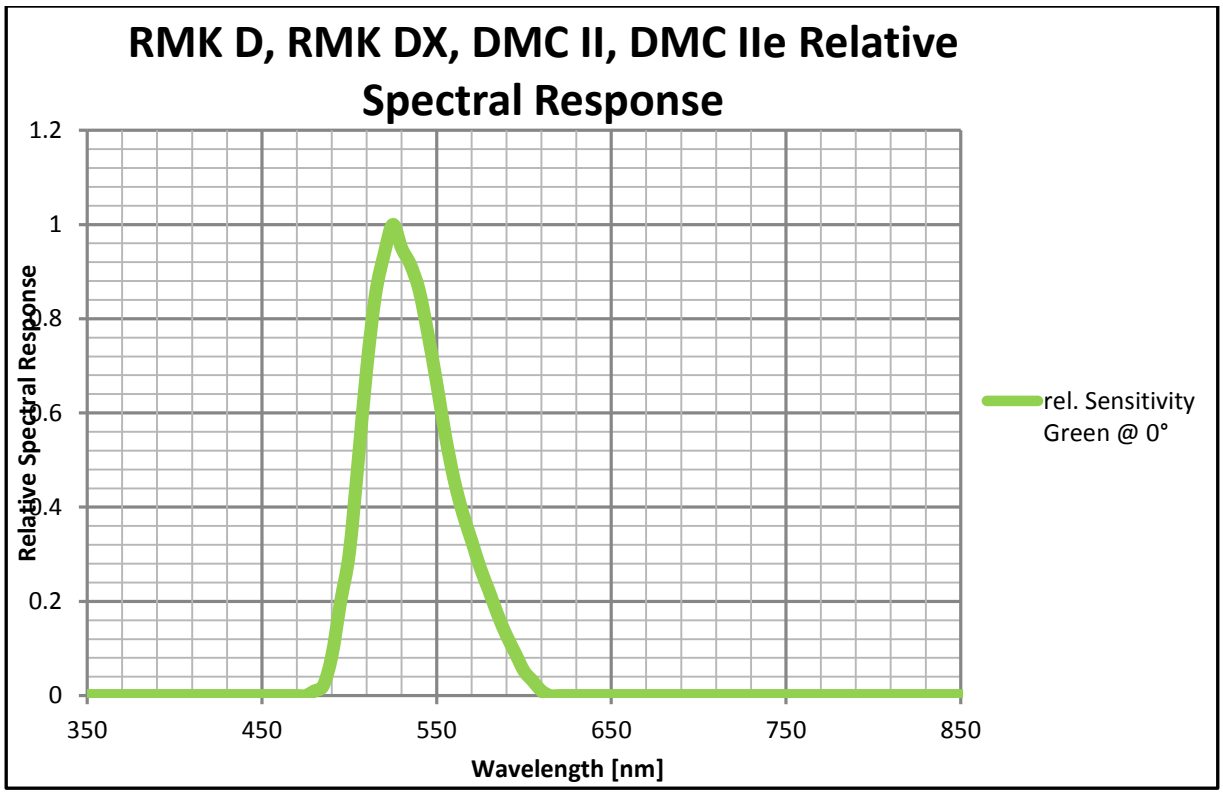
RMK D / RMK DX / DMC II / DMC IIe MS Green – MTF F/4.0 ; 45 mm– Temperature Stability



Radiometric Calibration

Sensitivity of Green camera

Spectral response curve of the single camera head.

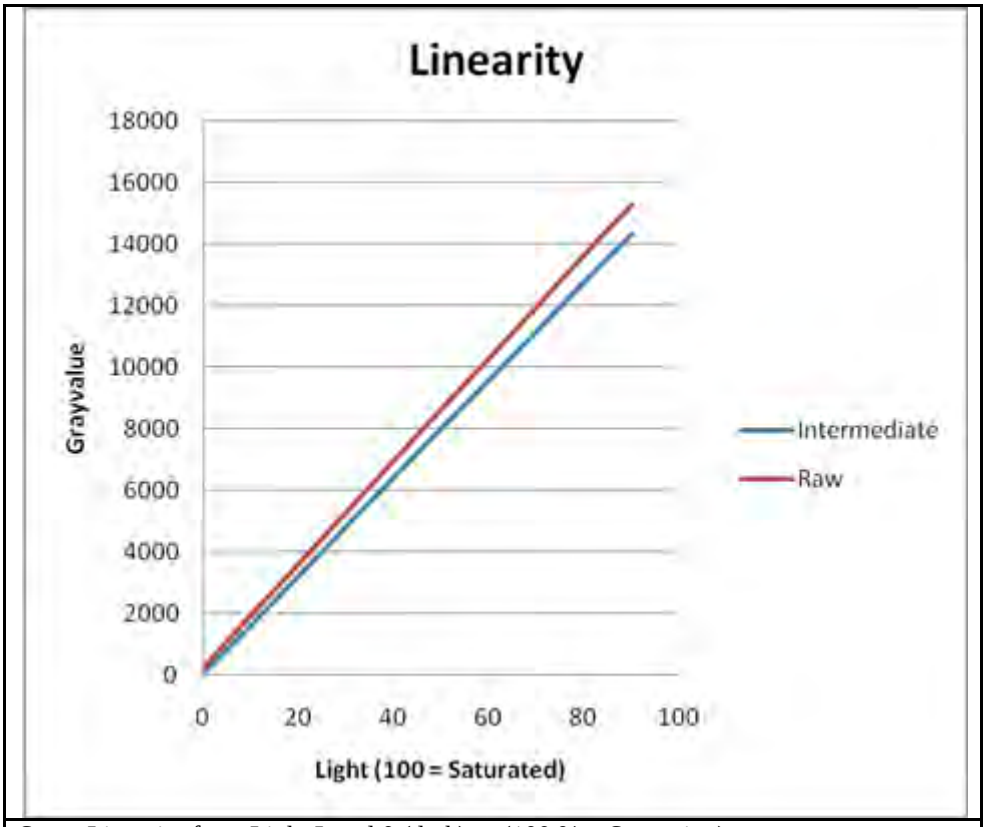


The sensitivity shows the spectral response curve of the single camera head including the optical system (optics, filter) and the sensor response. The DMC IIe 230 is calibrated with respect to the absolute spectrometer. This allows computing pixel radiance values from pixels digital numbers and is a camera type specific calibration.

Radiometric Calibration

Sensor Linearity (Reference)

The sensor linearity is measured in the Lab with calibrated spectrometer. This is a camera type specific calibration.
Below figure shows the linearity of the raw sensor and after flat fielding:



Senor Linearity from Light Level 0 (dark) to (100 % = Saturation)

The deviation from the linearity is below 1%.

Radiometric Calibration

Sensor Noise (Reference)

Sensor noise shows image noise with respect to the image center measured at an aperture of 8 with exposure time of 22msec. Sensor noise after calibration shall be less or equal 0.5% of radiometric resolution. At 14bit radiometric resolution 0.5% (of 16384) is equal to 82 gray values. This is a camera type specific calibration.

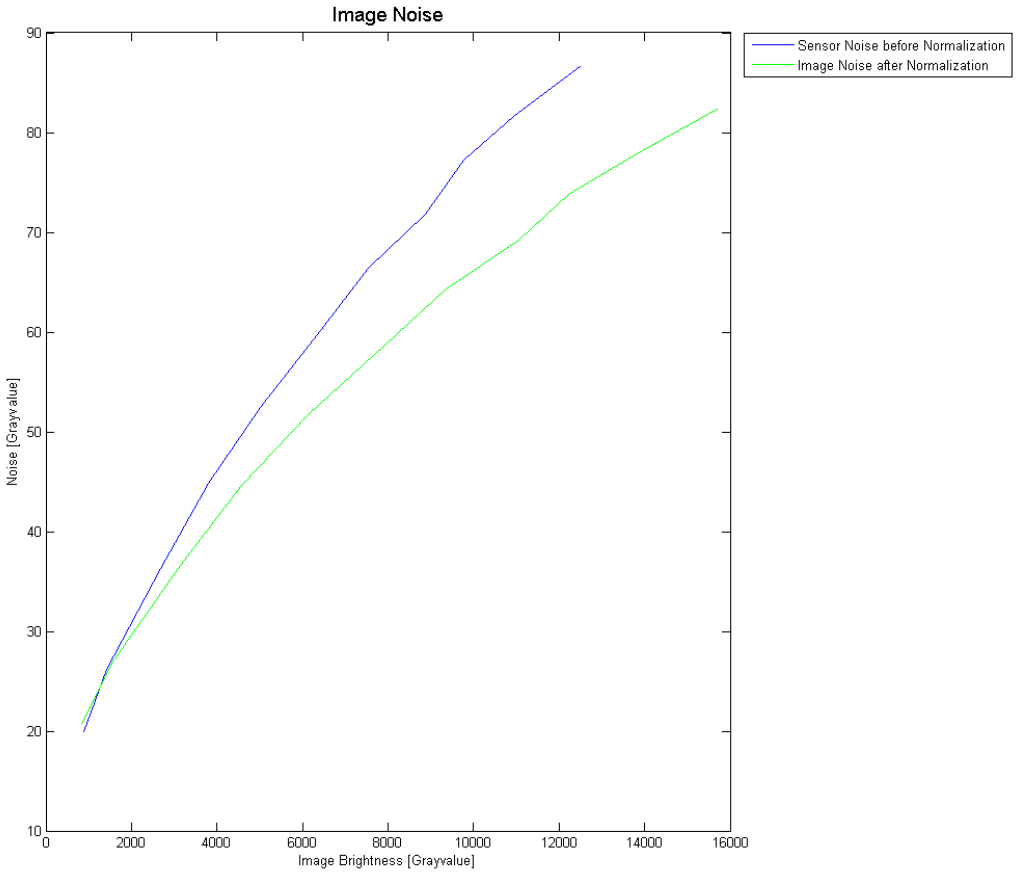


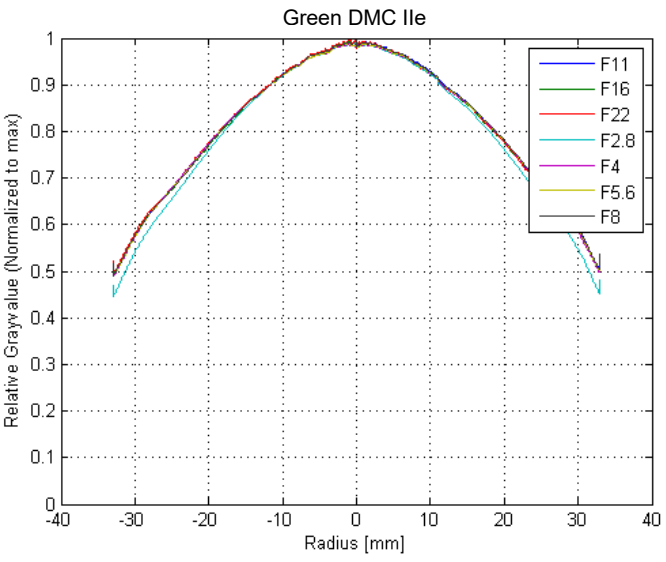
Image Noise before and after radiometric calibration

Radiometric Calibration

Aperture Correction

Green (00124739)

The light fall off to the border due the influence of the optics depends on the aperture used. Therefore this calibration approach delivers individual calibration images for each aperture (Full F-Stop). In general the light fall off is a function of the image height (radial distance from center). The figure below shows the profile from the upper left corner to the lower right corner of the calibration images.



Green

This is a camera type specific calibration.

Radiometric Calibration

Defect Pixel

Green (00124739)

Defect pixels are detected during radiometric calibration and will be corrected during radiometric processing of the images. The quantity and cumulative percentage and specification of defects is described in Appendix “Defect Pixel Recognition”.

Revision of calibration:	131073
CCDRevision:	1
Date Number:	1412091251
Date:	140930
Number of defect pixels:	2
Number of defect clusters:	0
Number of defect columns:	0

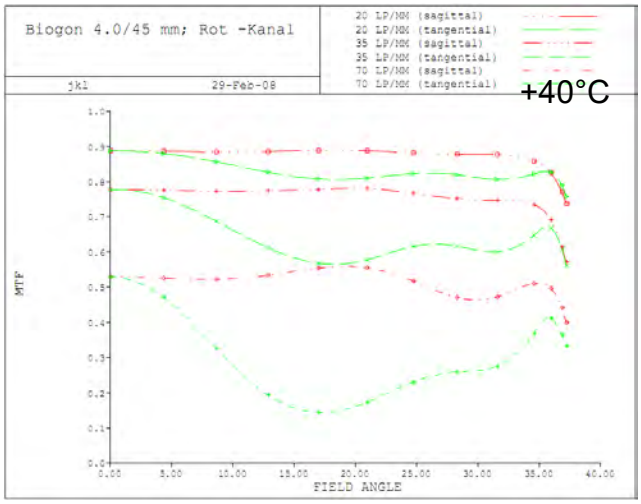
Nr	Row	Column
0	2233	1176
1	4612	4473

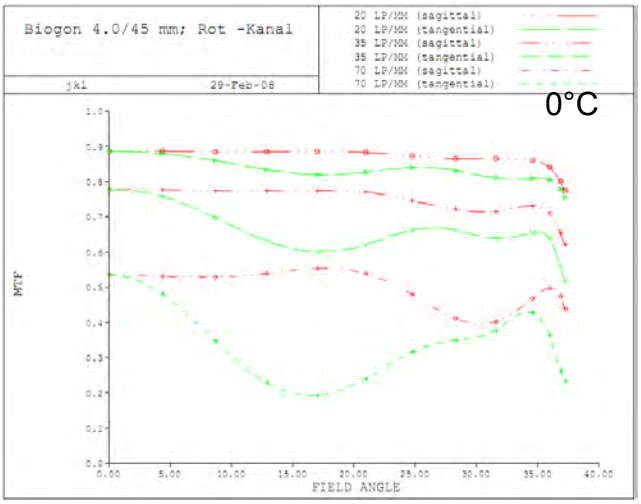
Defect Column RowStart ColumnStart RowEnd ColumnEnd

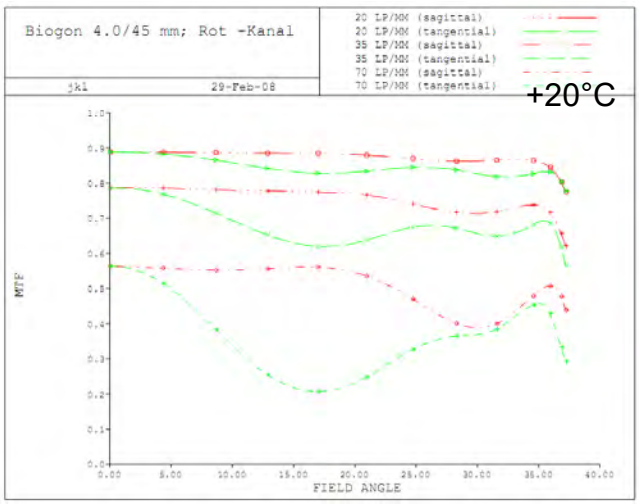
Optical System

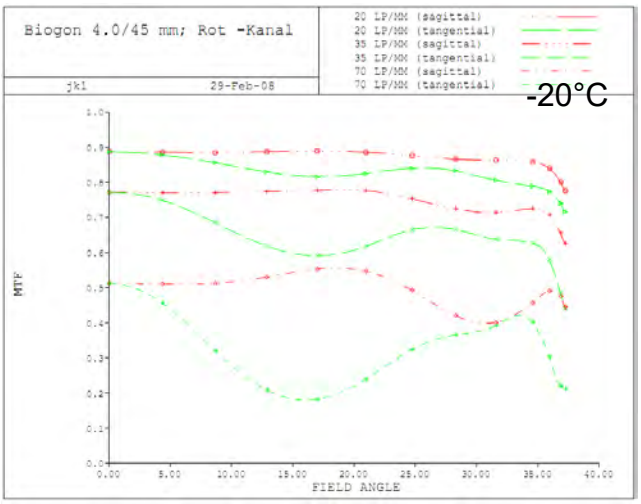
Modulation Transfer Function, MTF of Red camera

RMK D / RMK DX / DMC II / DMC IIe MS Red – MTF F/4.0 ; 45 mm– Temperature Stability





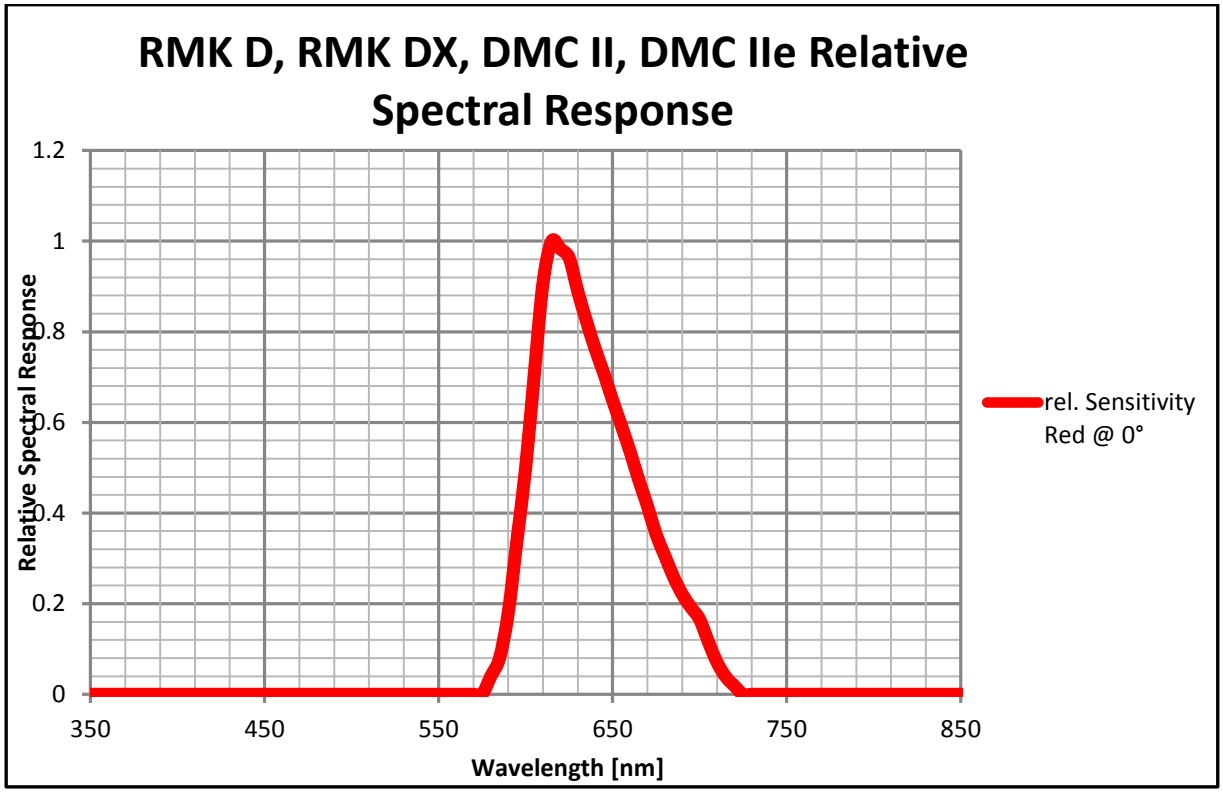




Radiometric Calibration

Sensitivity of Red camera

Spectral Response Curves of the single camera head.

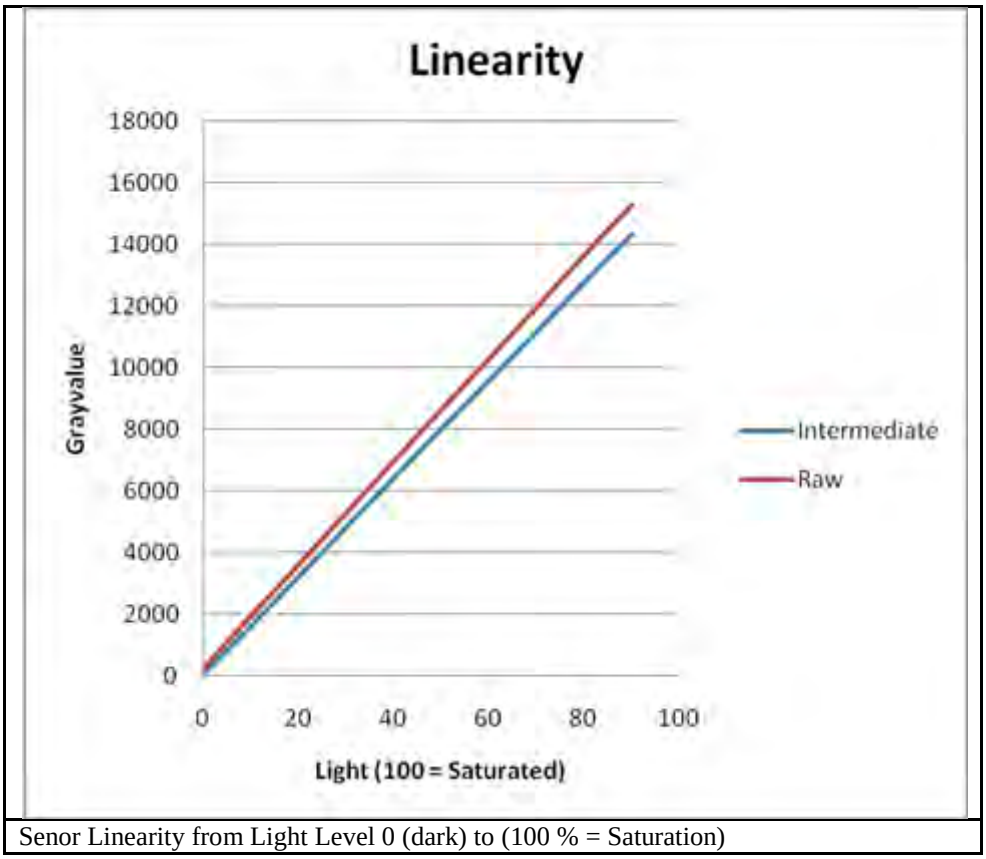


The sensitivity shows the spectral response curve of the single camera head including the optical system (optics, filter) and the sensor response. The DMC IIe 230 is calibrated with respect to the absolute spectrometer. This allows computing pixel radiance values from pixels digital numbers and is a camera type specific calibration.

Radiometric Calibration

Sensor Linearity (Reference)

The sensor linearity is measured in the Lab with calibrated spectrometer. This is a camera type specific calibration.
Below figure shows the linearity of the raw sensor and after flat fielding:



Senor Linearity from Light Level 0 (dark) to (100 % = Saturation)

The deviation from the linearity is below 1%.

Radiometric Calibration

Sensor Noise (Reference)

Sensor noise shows image noise with respect to the image center measured at an aperture of 8 with exposure time of 22msec. Sensor noise after calibration shall be less or equal 0.5% of radiometric resolution. At 14bit radiometric resolution 0.5% (of 16384) is equal to 82 gray values. This is a camera type specific calibration.

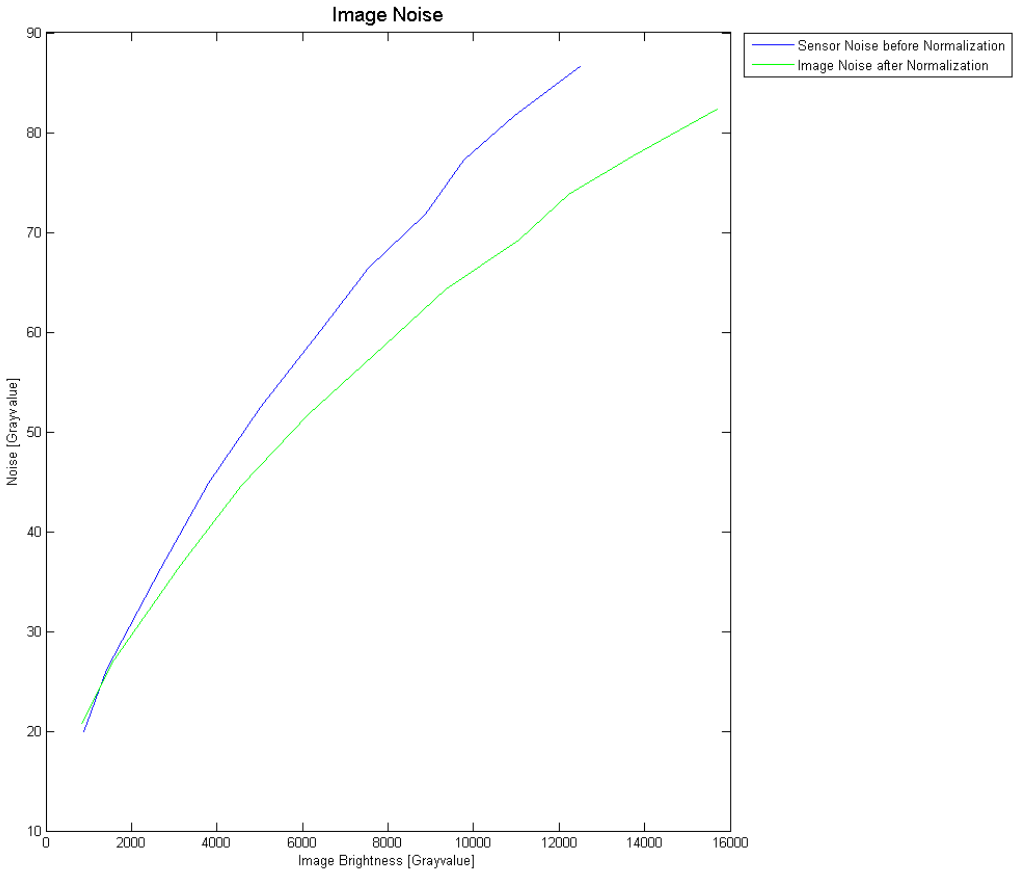


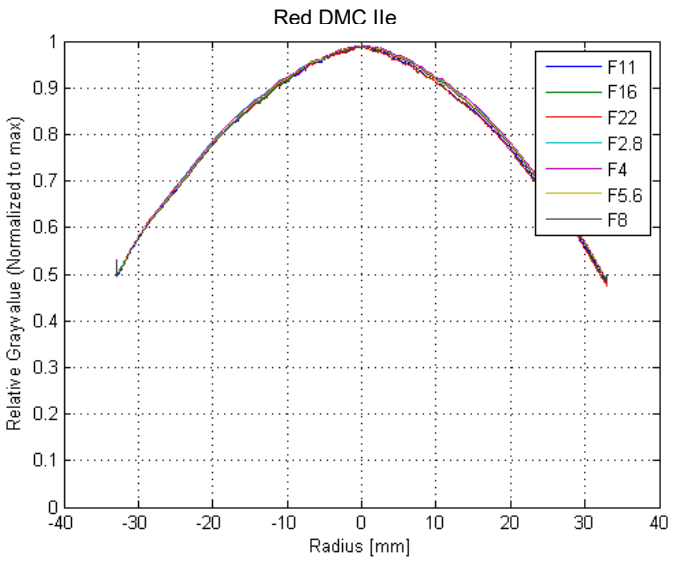
Image Noise before and after radiometric calibration

Radiometric Calibration

Aperture Correction

Red (00124693)

The light fall off to the border due the influence of the optics depends on the used aperture. Therefore this calibration approach has for each aperture (Full F-Stop) its own calibration image. In general the light fall off is a function of the image radius. In this calibration approach instead of function the real measured values in the image is used. The figure below shows the profile from the upper left corner to the lower right corner of each of this calibration images to give a feeling on the amount of correction.



Red

This is a camera type specific calibration.

Radiometric Calibration

Defect Pixel

Red (00124693)

Defect pixels are detected during radiometric calibration and will be corrected during radiometric processing of the images. The quantity and cumulative percentage and specification of defects is described in Appendix “Defect Pixel Recognition”.

Revision of calibration: 131073
CCDRevision: 1
Date Number: 1412093373
Date: 140930

Number of defect pixels: 4
Number of defect clusters: 0
Number of defect columns: 0

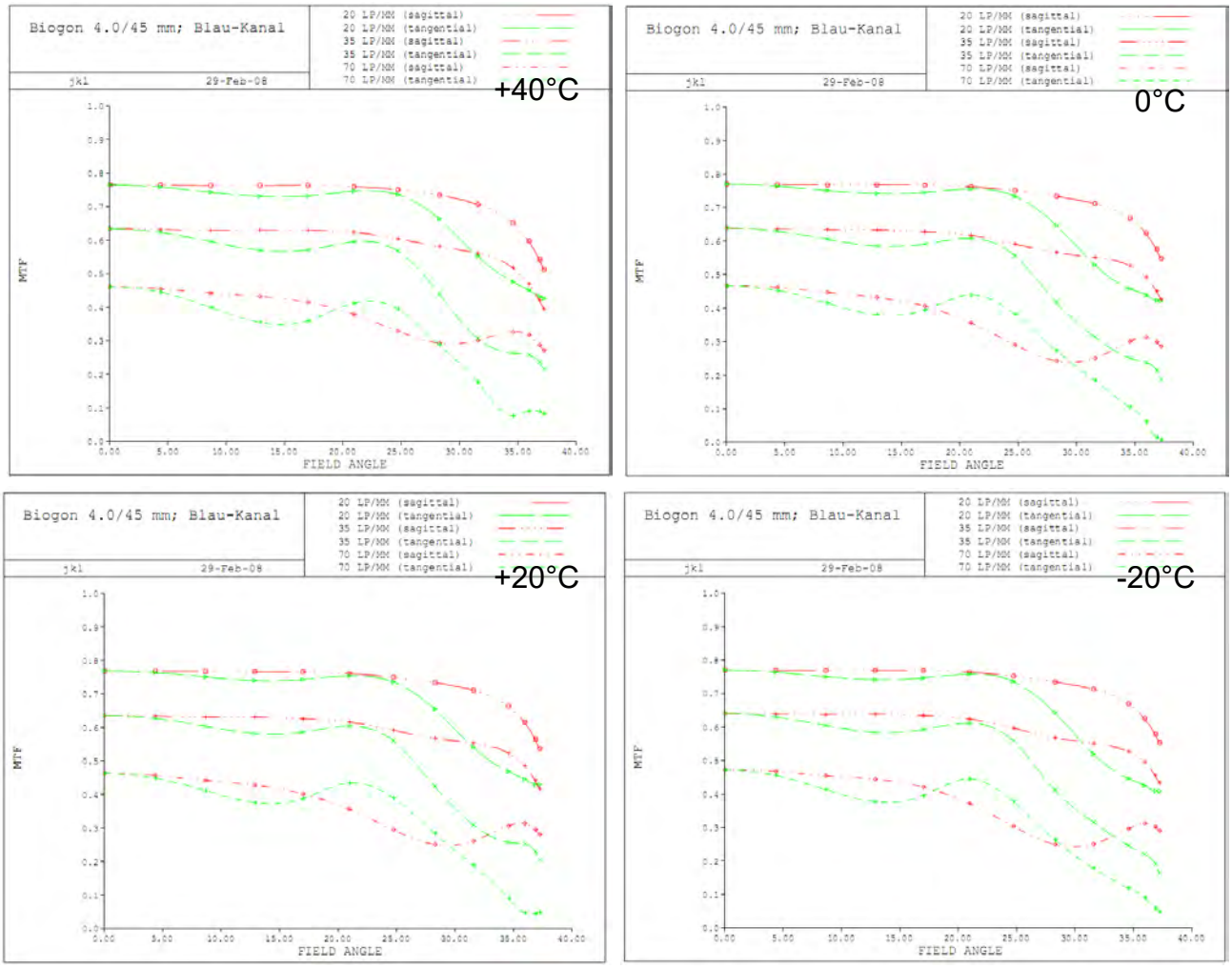
Nr	Row	Column
0	1906	69	1905
1	1908	68	1906
2	2011	716	2008
3	3302	1189	3298

Defect Column RowStart ColumnStart RowEnd ColumnEnd

Optical System

Modulation Transfer Function, MTF of Blue camera

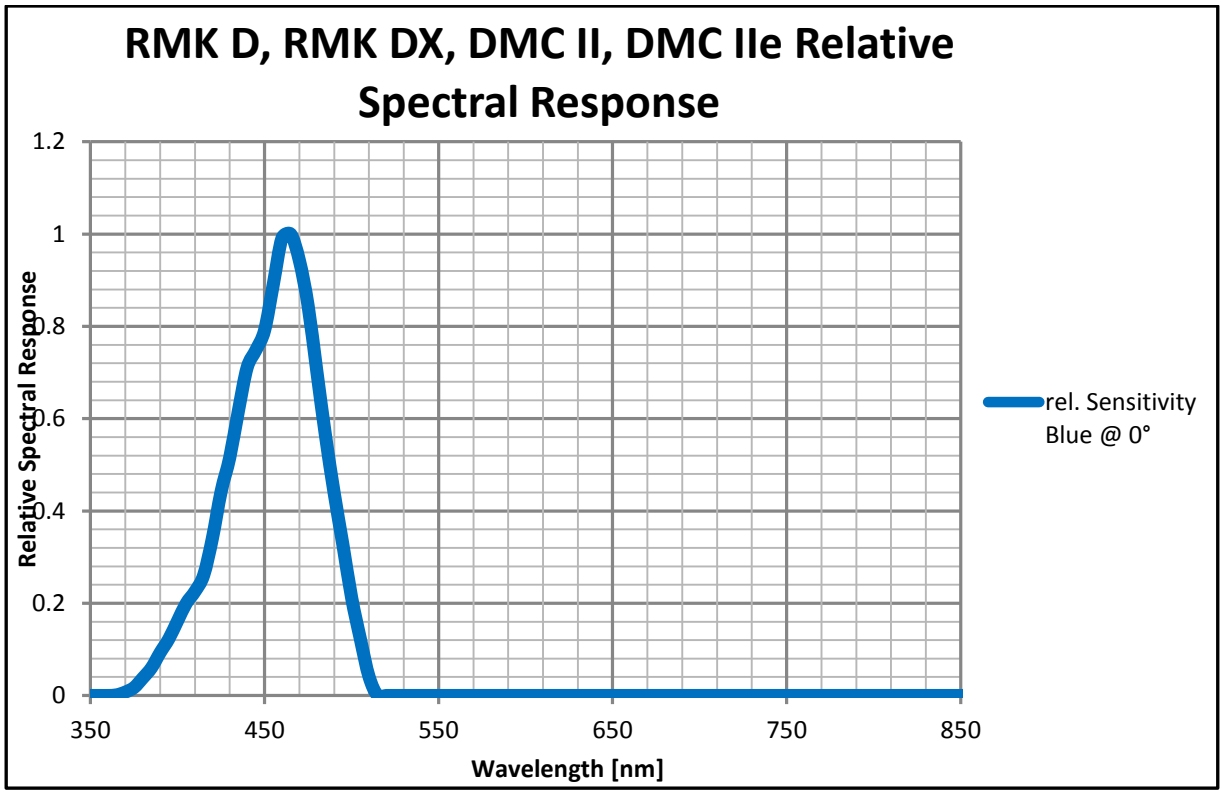
RMK D / RMK DX / DMC II / DMC IIe MS Blue – MTF F/4.0 ; 45 mm– Temperature Stability



Radiometric Calibration

Sensitivity of Blue camera

Spectral Response Curves of the single camera head.

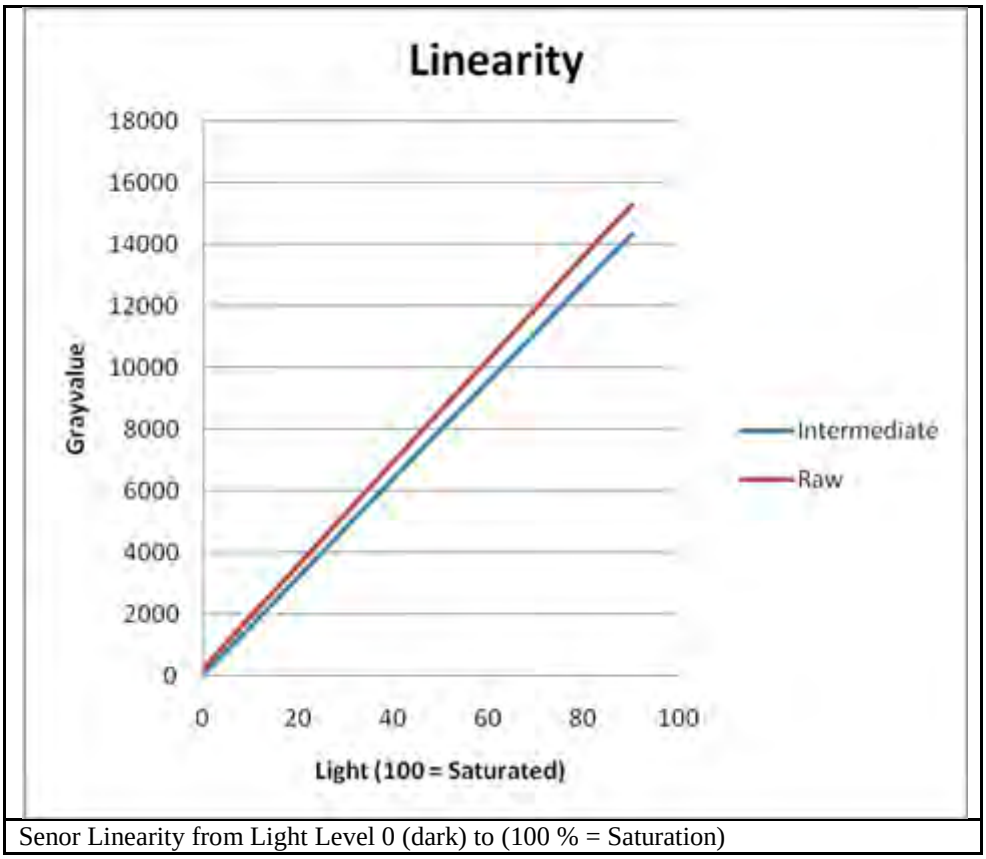


The sensitivity shows the spectral response curve of the single camera head including the optical system (optics, filter) and the sensor response. The DMC IIe 230 is calibrated with respect to the absolute spectrometer. This allows computing pixel radiance values from pixels digital numbers and is a camera type specific calibration.

Radiometric Calibration

Sensor Linearity (Reference)

The sensor linearity is measured in the Lab with calibrated spectrometer. This is a camera type specific calibration.
Below figure shows the linearity of the raw sensor and after flat fielding:



Senor Linearity from Light Level 0 (dark) to (100 % = Saturation)

The deviation from the linearity is below 1%.

Radiometric Calibration

Sensor Noise (Reference)

Sensor noise shows image noise with respect to the image center measured at an aperture of 8 with exposure time of 22msec. Sensor noise after calibration shall be less or equal 0.5% of radiometric resolution. At 14bit radiometric resolution 0.5% (of 16384) is equal to 82 gray values. This is a camera type specific calibration.

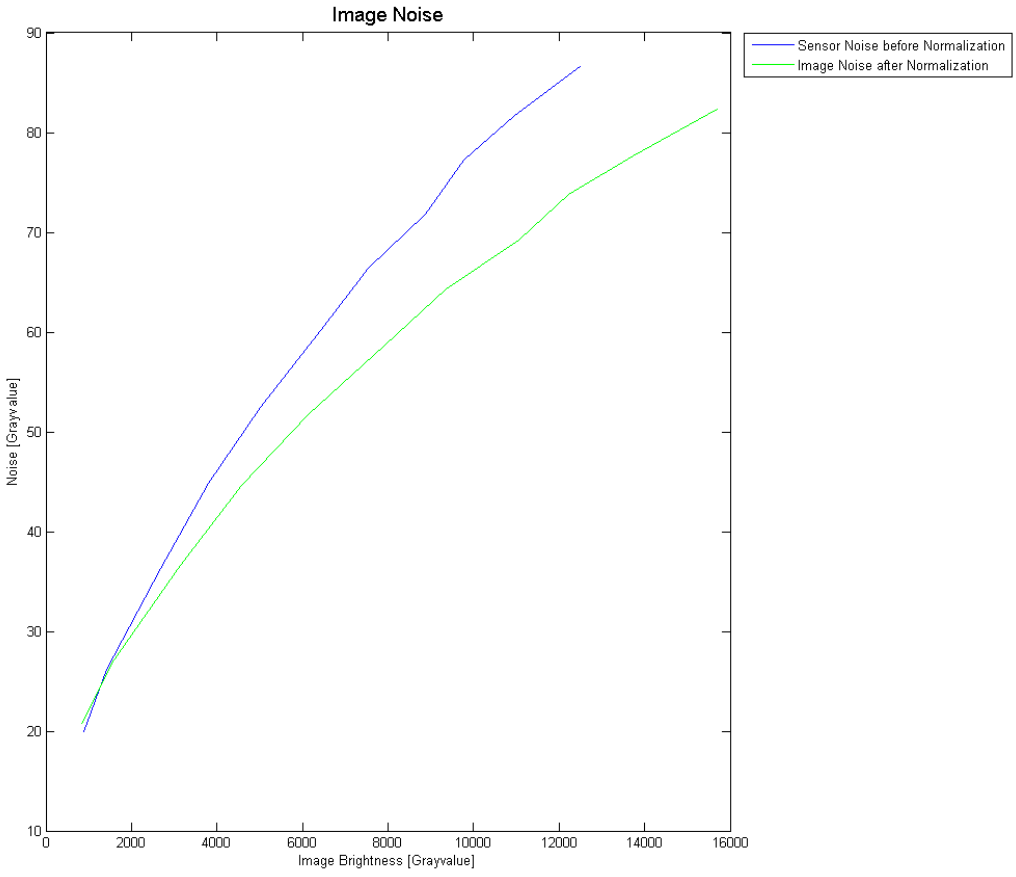


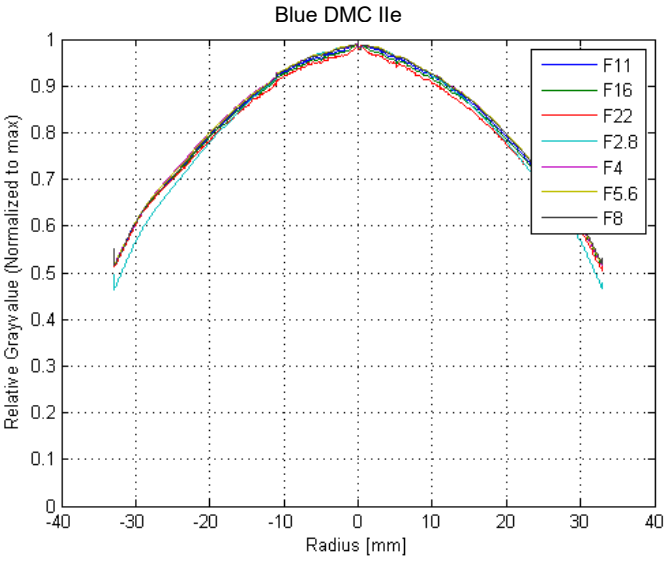
Image Noise before and after radiometric calibration

Radiometric Calibration

Aperture Correction

Blue (00124736)

The light fall off to the border due the influence of the optics depends on the used aperture. Therefore this calibration approach has for each aperture (Full F-Stop) its own calibration image. In general the light fall off is a function of the image radius. In this calibration approach instead of function the real measured values in the image is used. The figure below shows the profile from the upper left corner to the lower right corner of each of this calibration images to give a feeling on the amount of correction.



Blue

This is a camera type specific calibration.

Radiometric Calibration

Defect Pixel

Blue (00124736)

Defect pixels are detected during radiometric calibration and will be corrected during radiometric processing of the images. The quantity and cumulative percentage and specification of defects is described in Appendix “Defect Pixel Recognition”.

Revision of calibration:	131073
CCDRevision:	1
Date Number:	1412092319
Date:	140930
Number of defect pixels:	6
Number of defect clusters:	0
Number of defect columns:	0

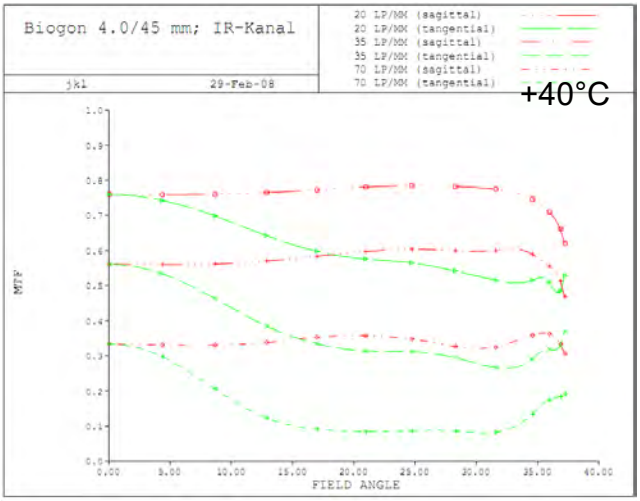
Nr	Row	Column
0	5491	104
1	5492	104
2	3577	541
3	3578	541
4	6134	6030
5	6135	6030

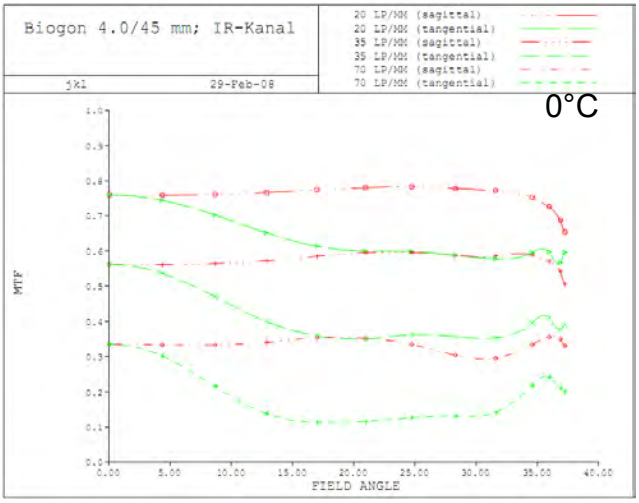
Defect Column RowStart ColumnStart RowEnd ColumnEnd

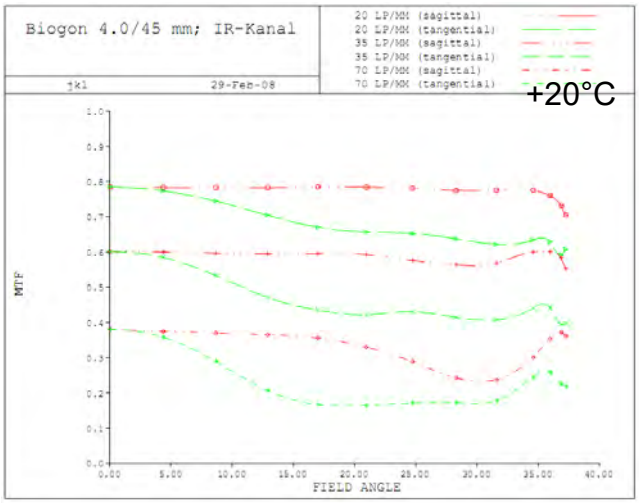
Optical System

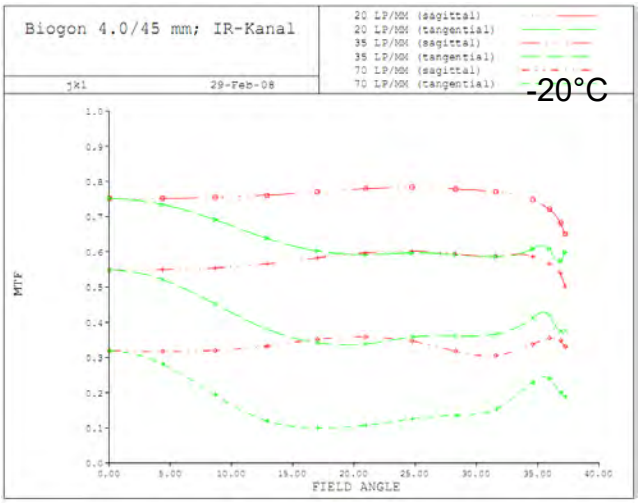
Modulation Transfer Function, MTF of IR camera

RMK D / RMK DX / DMC II / DMC IIe MS IR – MTF F/4.0 ; 45 mm– Temperature Stability





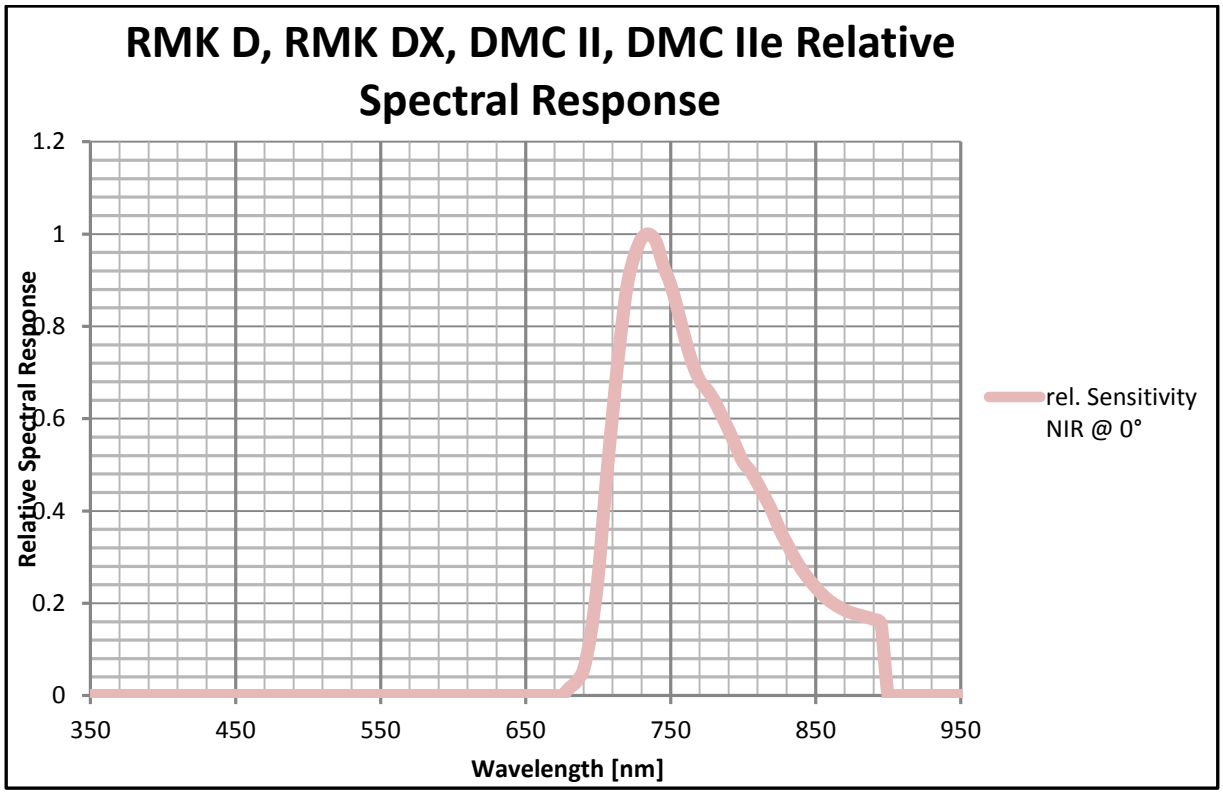




Radiometric Calibration

Sensitivity of NIR camera

Spectral Response Curves of the single camera head.

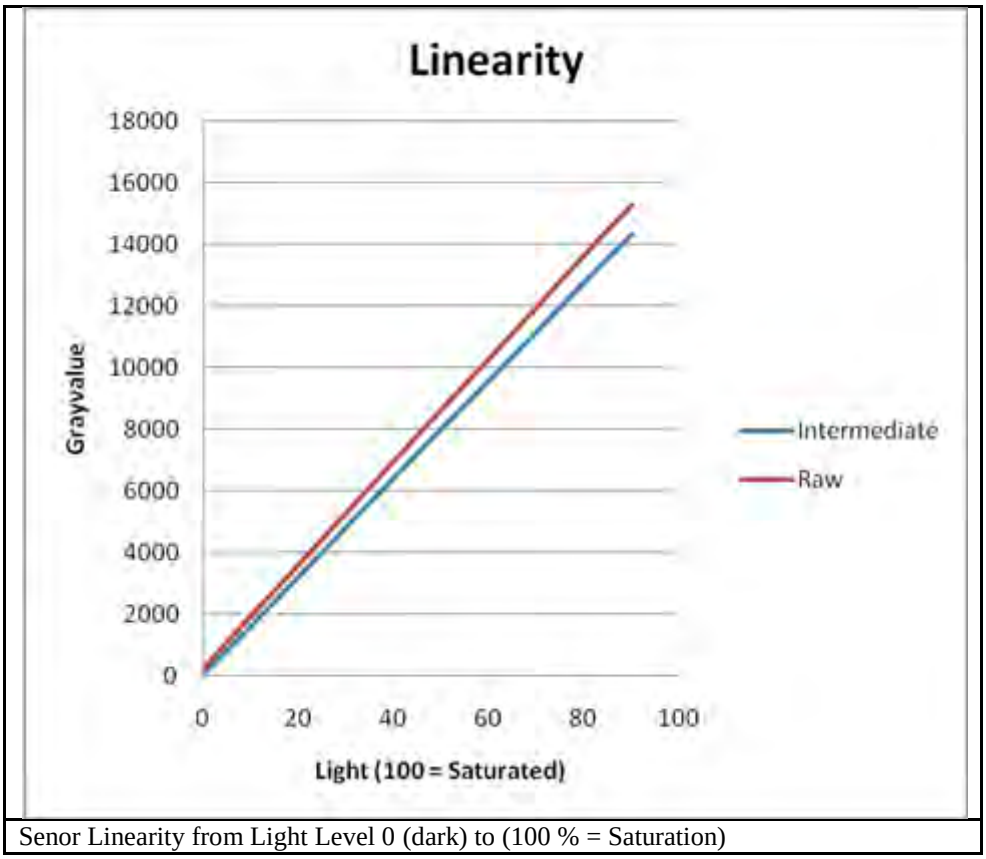


The sensitivity shows the spectral response curve of the single camera head including the optical system (optics, filter) and the sensor response. The DMC IIe 230 is calibrated with respect to the absolute spectrometer. This allows computing pixel radiance values from pixels digital numbers and is a camera type specific calibration.

Radiometric Calibration

Sensor Linearity (Reference)

The sensor linearity is measured in the Lab with calibrated spectrometer. This is a camera type specific calibration.
Below figure shows the linearity of the raw sensor and after flat fielding:



Senor Linearity from Light Level 0 (dark) to (100 % = Saturation)

The deviation from the linearity is below 1%.

Radiometric Calibration

Sensor Noise (Reference)

Sensor noise shows image noise with respect to the image center measured at an aperture of 8 with exposure time of 22msec. Sensor noise after calibration shall be less or equal 0.5% of radiometric resolution. At 14bit radiometric resolution 0.5% (of 16384) is equal to 82 gray values. This is a camera type specific calibration.

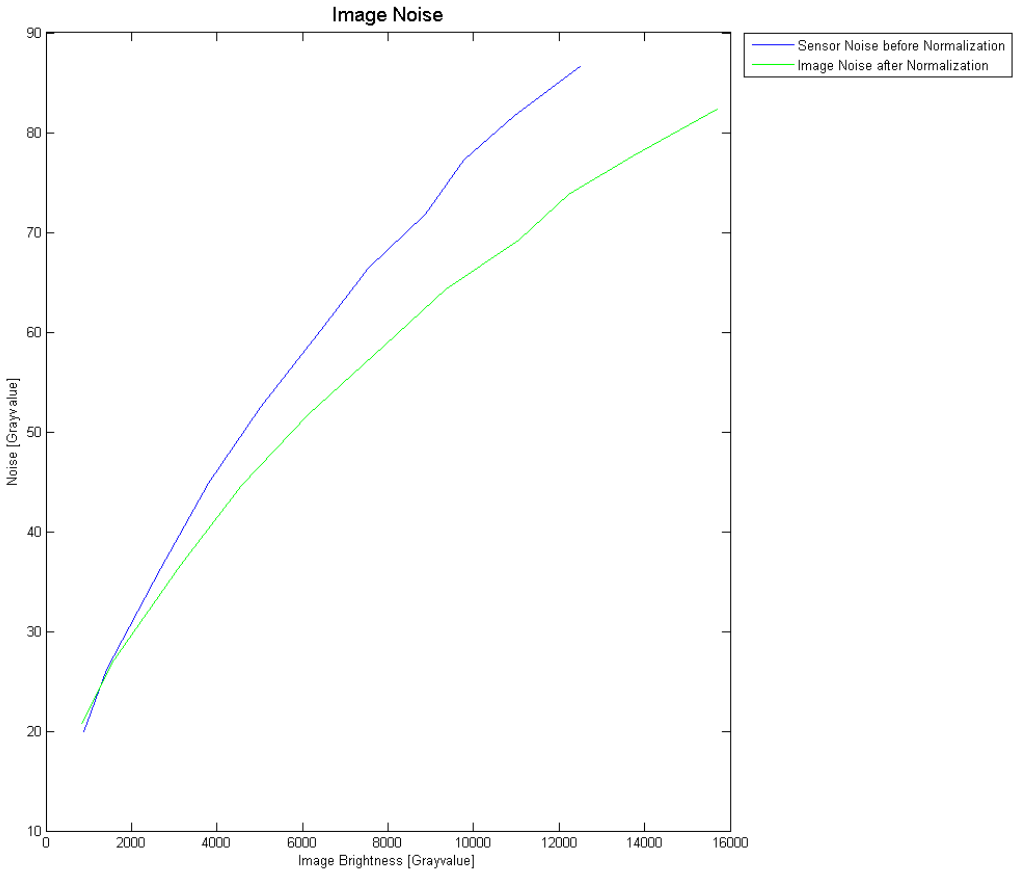


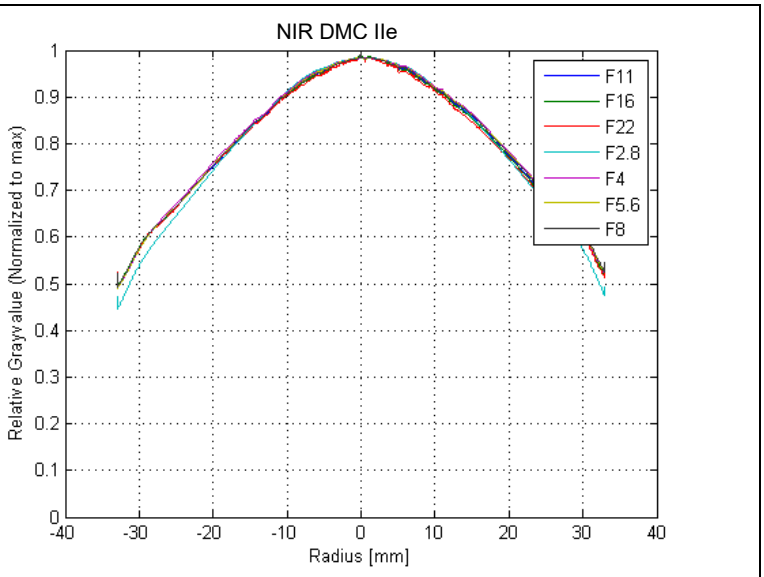
Image Noise before and after radiometric calibration

Radiometric Calibration

Aperture Correction

NIR (00118804)

The light fall off to the border due the influence of the optics depends on the used aperture. Therefore this calibration approach has for each aperture (Full F-Stop) its own calibration image. In general the light fall off is a function of the image radius. In this calibration approach instead of function the real measured values in the image is used. The figure below shows the profile from the upper left corner to the lower right corner of each of this calibration images to give a feeling on the amount of correction.



NIR

This is a camera type specific calibration.

Radiometric Calibration

Defect Pixel

NIR (00118804)

Defect pixels are detected during radiometric calibration and will be corrected during radiometric processing of the images. The quantity and cumulative percentage and specification of defects is described in Appendix “Defect Pixel Recognition”.

Revision of calibration:	131073	
CCDRevision:	1	
Date Number:		1418230290
Date:		141210
Number of defect pixels:	236	
Number of defect clusters:	0	
Number of defect columns:	0	

Nr	Row	Column
0	2516	4988
1	30	773
2	81	5346
3	99	2568
4	100	4557
5	160	3924
6	161	3154
7	319	3355
8	377	617
9	409	5164
10	411	5155
11	634	4946
12	658	302
13	695	5362
14	775	5479
15	918	4606
16	1024	1833
17	1184	1331
18	1189	5350
19	1213	1381
20	1226	3741
21	1231	830
22	1282	5470
23	1282	4383
24	1298	1852
25	1350	2496
26	1455	4483
27	1458	1475
28	1458	2528
29	1519	1174
30	1589	5290
31	1613	2570
32	1614	2566
33	1636	5967
34	1706	5005
35	1736	4601
36	1767	4569
37	1776	5934
38	1784	3836
39	1852	6059
40	1855	4146
41	1892	1566
42	1902	3591
43	1957	2926

44	2012	1083
45	2015	6080
46	2043	4346
47	2123	750
48	2124	791
49	2151	3473
50	2162	4454
51	2205	1068
52	2295	476
53	2327	5169
54	2354	4722
55	2524	2030
56	2567	2606
57	2804	4915
58	2806	4258
59	2817	2693
60	2829	5095
61	2830	5019
62	2859	1877
63	2878	3616
64	2885	971
65	2888	4685
66	2927	3534
67	3018	5347
68	3037	2915
69	3096	3155
70	3199	5615
71	3250	5987
72	3251	5987
73	3270	317
74	3320	4513
75	3350	1101
76	3376	4158
77	3381	3580
78	3416	1723
79	3490	725
80	3553	6054
81	3565	2889
82	3591	5317
83	3639	5841
84	3645	4247
85	3646	4513
86	3646	4549
87	3757	6090
88	3783	532
89	3870	3159
90	3889	3980
91	3896	5055
92	3954	4639
93	4022	3409
94	4028	4660
95	4123	5622
96	4164	5004
97	4165	3110
98	4167	1878
99	4178	337
100	4275	4660
101	4301	5494
102	4363	3689
103	4387	4723
104	4404	4766
105	4438	6056
106	4442	2374
107	4476	5080
108	4489	3059
109	4627	4233
110	4645	4259
111	4655	2144
112	4670	5171
113	4701	335
114	4704	3645
115	4712	3499
116	4731	1731
117	4737	2332
118	4749	5879
119	4752	1342
120	4764	4945

121	4777	3462
122	4790	5196
123	4805	2251
124	4826	1827
125	4853	4011
126	4859	2488
127	5075	2739
128	5108	3954
129	5110	3865
130	5138	1019
131	5142	2654
132	5142	5974
133	5233	2227
134	5243	902
135	5284	2860
136	5289	869
137	5294	2742
138	5314	5077
139	5373	4781
140	5397	2013
141	5408	2335
142	5436	238
143	5442	1958
144	5443	1957
145	5481	793
146	5495	5489
147	5540	1759
148	5595	5447
149	5602	4827
150	5622	5112
151	5637	6013
152	5670	4639
153	5676	2638
154	5731	4110
155	5741	4712
156	5830	5779
157	5832	5196
158	5835	1188
159	5836	2627
160	5849	2492
161	5856	1032
162	5863	5554
163	5863	3874
164	5876	1355
165	5930	5414
166	5959	4501
167	5962	5895
168	5964	5230
169	5966	3821
170	5969	3867
171	5975	3793
172	5977	5705
173	5983	3889
174	5990	3832
175	6023	4699
176	6082	2916
177	6086	4173
178	6121	3006
179	6126	4280
180	6128	2954
181	6142	2260
182	6142	4551
183	6146	4412
184	6153	3309
185	6156	4577
186	6220	5917
187	6221	3046
188	6232	5835
189	6240	732
190	6245	3335
191	6255	5783
192	6263	4349
193	6275	179
194	6279	4157
195	6280	549
196	6285	3469
197	6332	3355

198	6332	3355
199	6333	3134
200	6340	3102
201	6351	5669
202	6351	5454
203	6369	5918
204	6389	5248
205	6417	4218
206	6422	5892
207	6424	4681
208	6434	683
209	6436	2044
210	6442	3310
211	6451	5294
212	6452	1295
213	6464	2809
214	6467	4938
215	6484	3303
216	6549	3861
217	6554	5988
218	6572	3970
219	6600	3817
220	6608	667
221	6646	5523
222	6657	3102
223	6735	1753
224	6761	5934
225	6765	4628
226	6770	4055
227	6772	2680
228	6786	5345
229	6788	4513
230	6799	5611
231	6803	206
232	6809	4615
233	6819	1407
234	6832	296
235	6835	3973

Defect Column RowStart ColumnStart RowEnd ColumnEnd

Sensor Geometric Accuracy

Large area CCD imagers are composed (stitched) from several blocks. Stitching on wafer with semiconductor lithographic equipment results in geometric accuracy better than 0.1µm (Stoldt, H. (2010).
Therefore the geometric accuracy of individual pixels within a block can be assumed as better or equal the stitching accuracy.

Defect Pixel Recognition

The table below shows the maximal allowed physical defects on the CCD Sensor and its definitions.

	Description	CCD Spec
Pixel	Bright image	Pixel whose signal, at nominal light (illumination at 50% of the linear range), deviates more than ±30% from its neighboring pixels.
	Dark image	Pixel whose signal, in dark, deviates more than 6mV from its neighboring pixels (about 1% of nominal light).
	Max Count	PAN ≤ 3500 MS <500

	Description	CCD Spec
Column	Definition	A column which has more than 8 pixel defects in 1 1x 12 kernel Column defects must be horizontally separated by 5 columns for single line defects and 10 for double line defects
	Recognition (bright and dark)	Same as defect pixel recognition
	Max Single column	PAN ≤ 140 MS ≤ 20
	Max double Column	PAN ≤ 40 MS ≤ 6

The Post-Processing-Software is correcting following pixel and columns:

	PPS Correction
Pixel	Pixel whose gray value in a 16 x16 kernel differs from the median more than 30%

	PPS Correction
Column	Pixel whose gray value in a 16 x16 kernel differs from the median more than 5% and more than 15 defects in one column

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Zeitler W., Dörstel C., Jacobsen K. (2002): Geometric calibration of the DMC: Method and Results, Proceedings ASPRS, Denver, USA.

Ryan R., Pagnutti M. (2009): Enhanced Absolute and Relative Radiometric Calibration for Digital Aerial Cameras, in: Fritsch D. (Ed.), Photogrammetric Week 2009, Wichmann-Verlag, pp. 81-90.

Doering D., Hildebrand J., Diete N. (2009): Advantages of customized optical design for aerial survey cameras, in: Fritsch D. (Ed.), Photogrammetric Week 2009, Wichmann-Verlag, pp. 69-80.

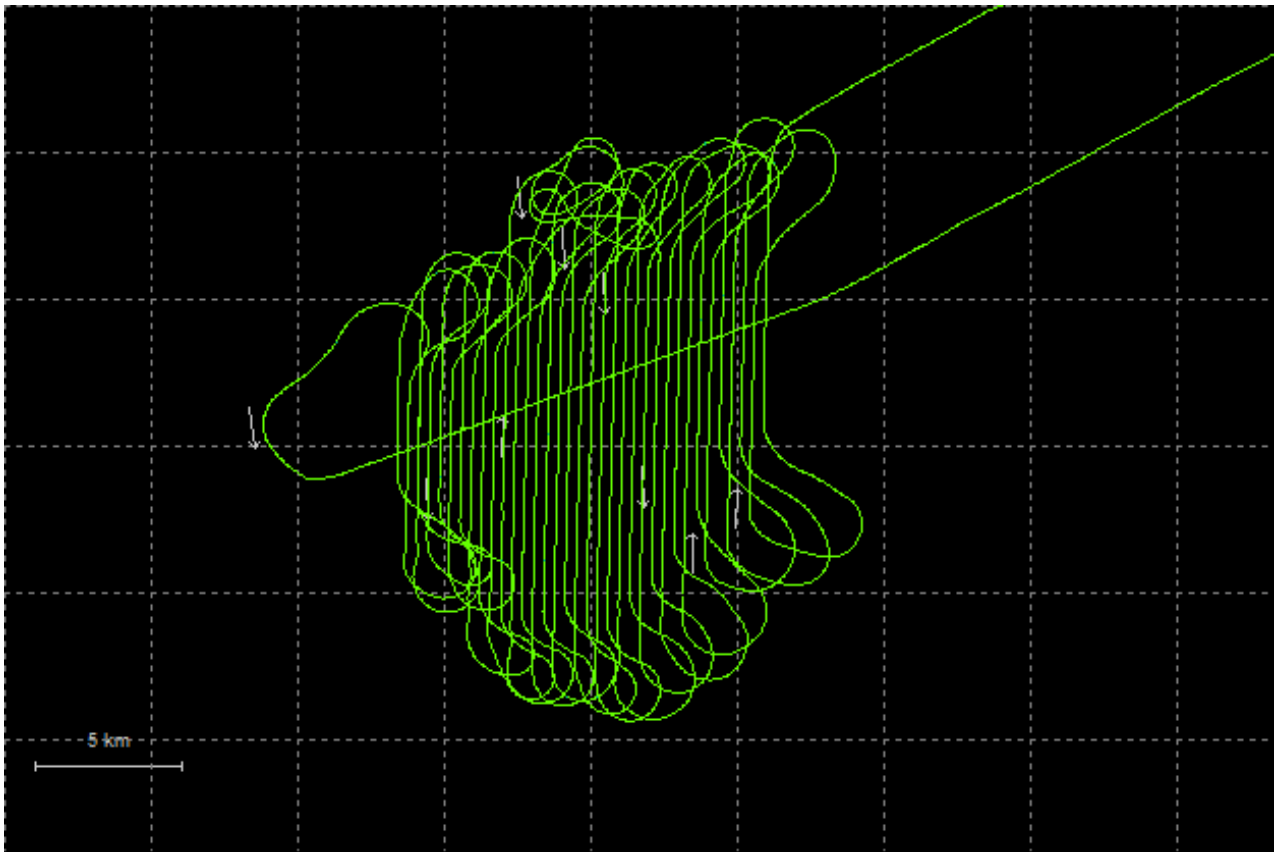
Stoldt, H. (2010): DALSA Ultra large CCD technology Customized for Aerial Photogrammetry. At: ASPRS 2010, San Diego, USA, p. 15.

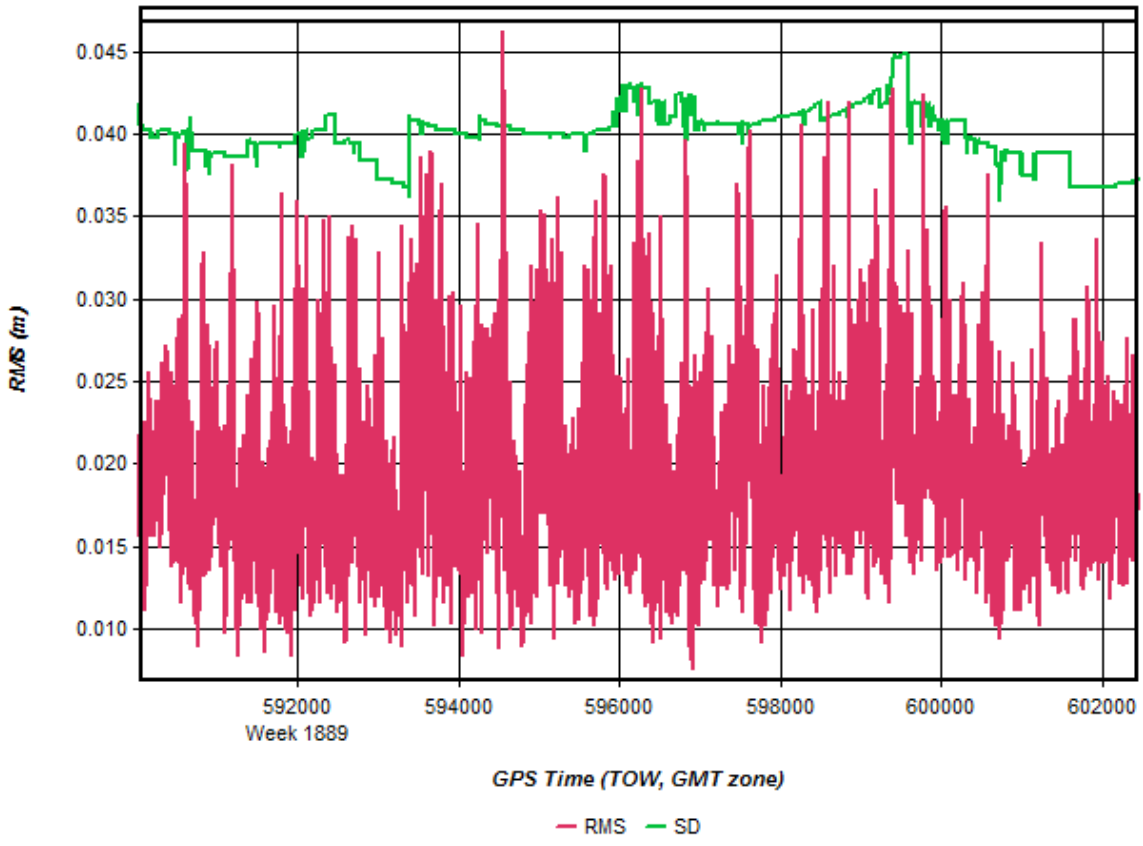
Appendix B

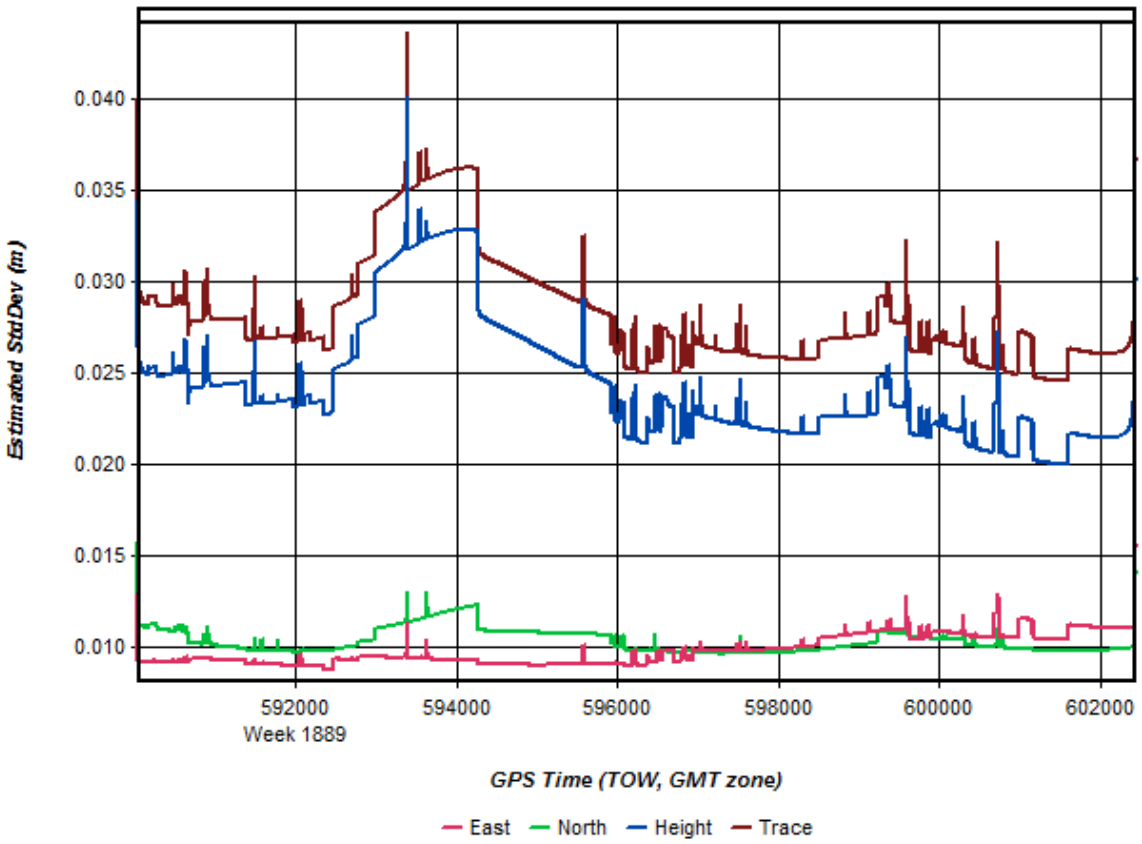
GPS/IMU Processing Statistics
Flight Logs

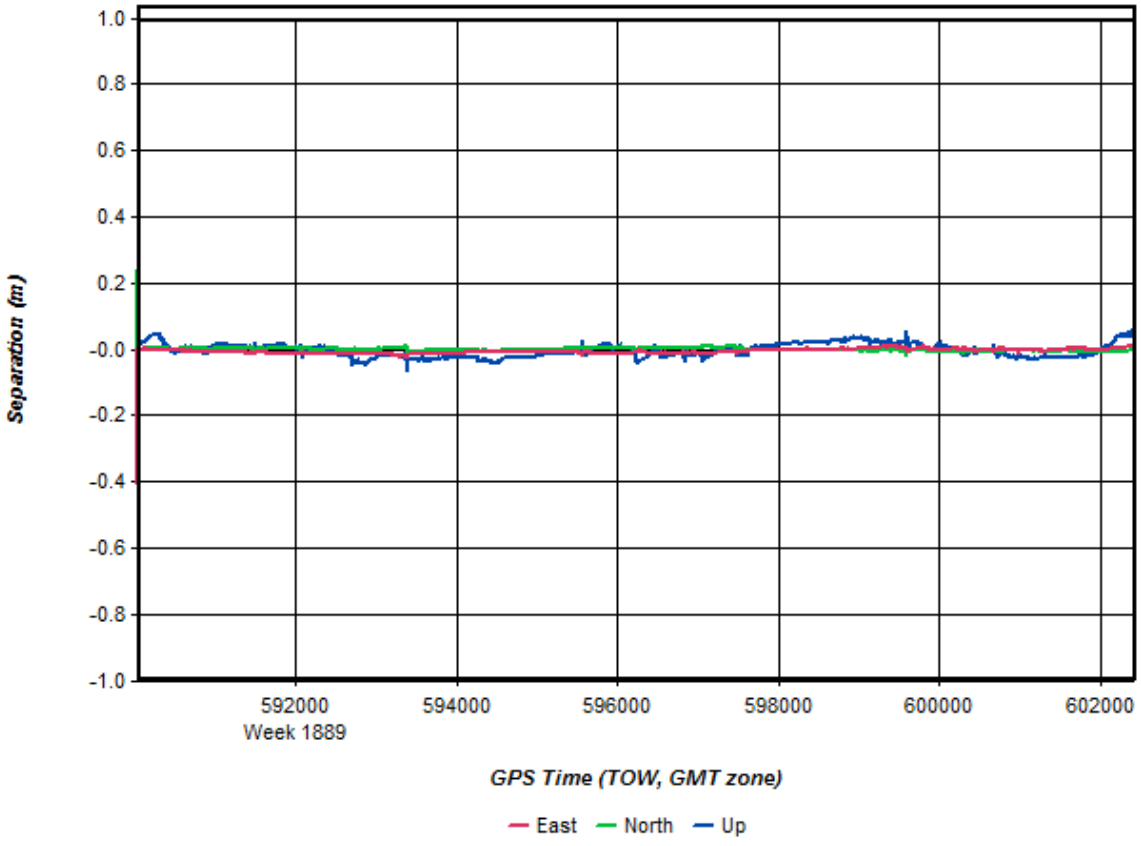
There was one total lift. Graph reports generated from processing software and flight logs are found on the following pages.

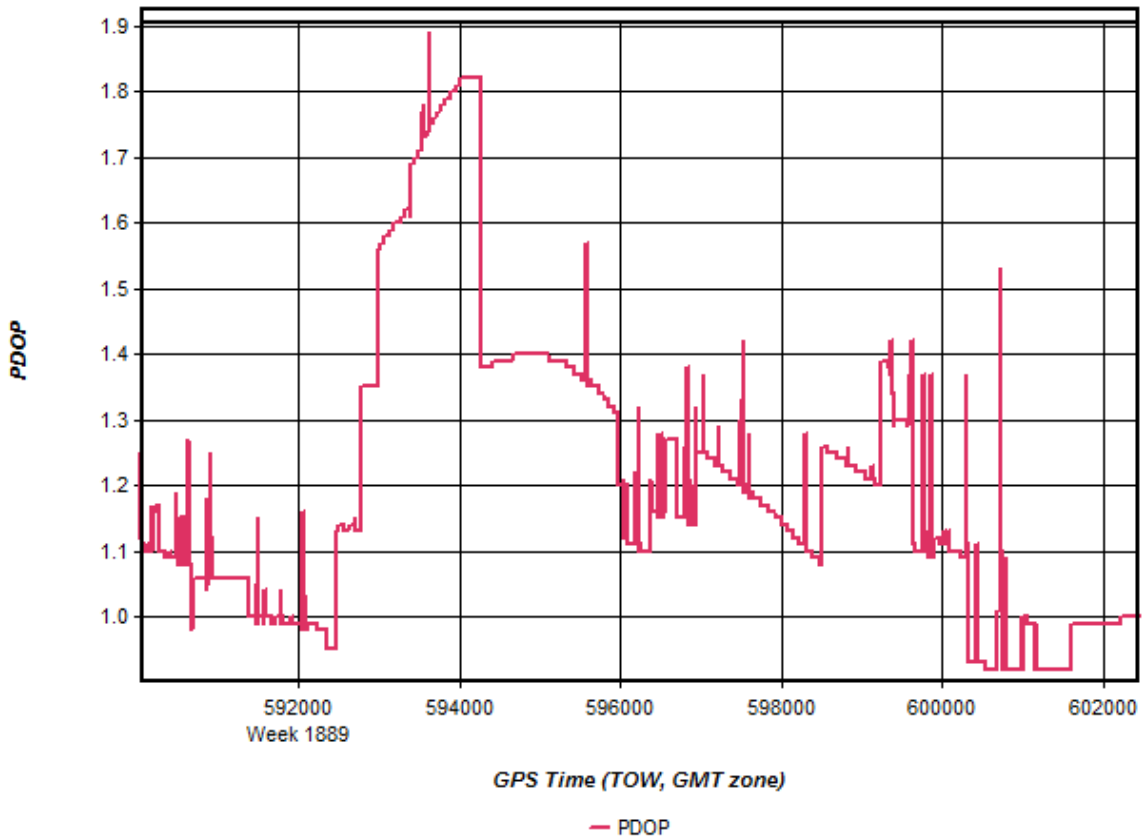
Mar 26, 2016-A

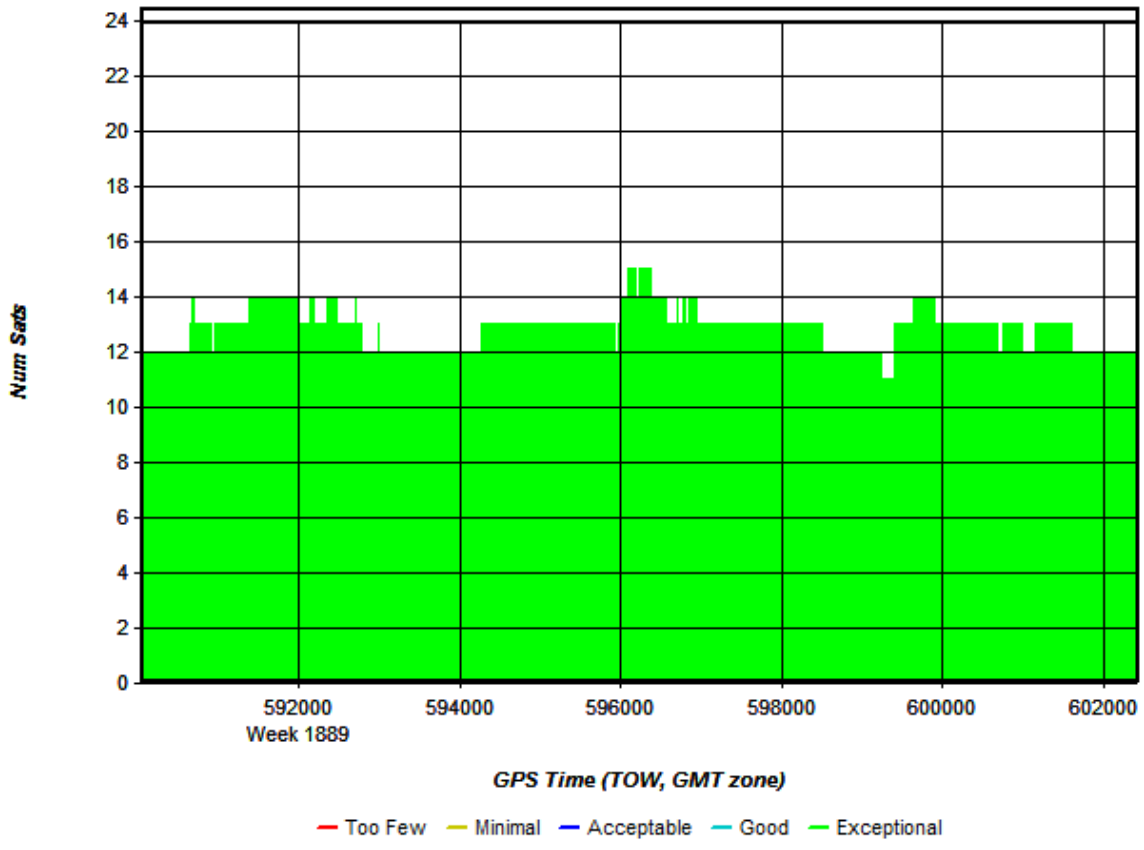

5 km

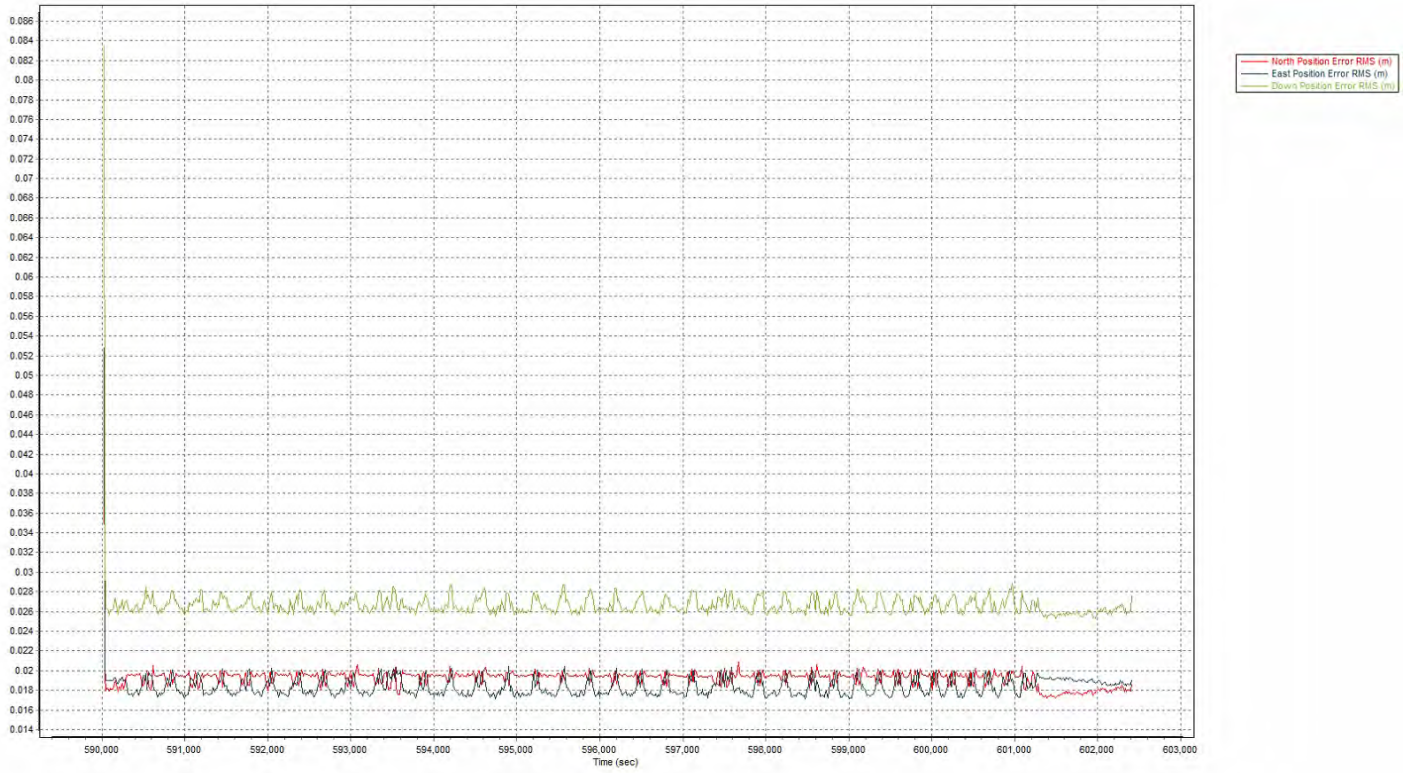

0.045
0.040
0.035
0.030
0.025
0.020
0.015
0.010
RMS (m)
592000
Week 1889
594000
596000
598000
600000
602000
GPS Time (TOW, GMT zone)
RMS
SD

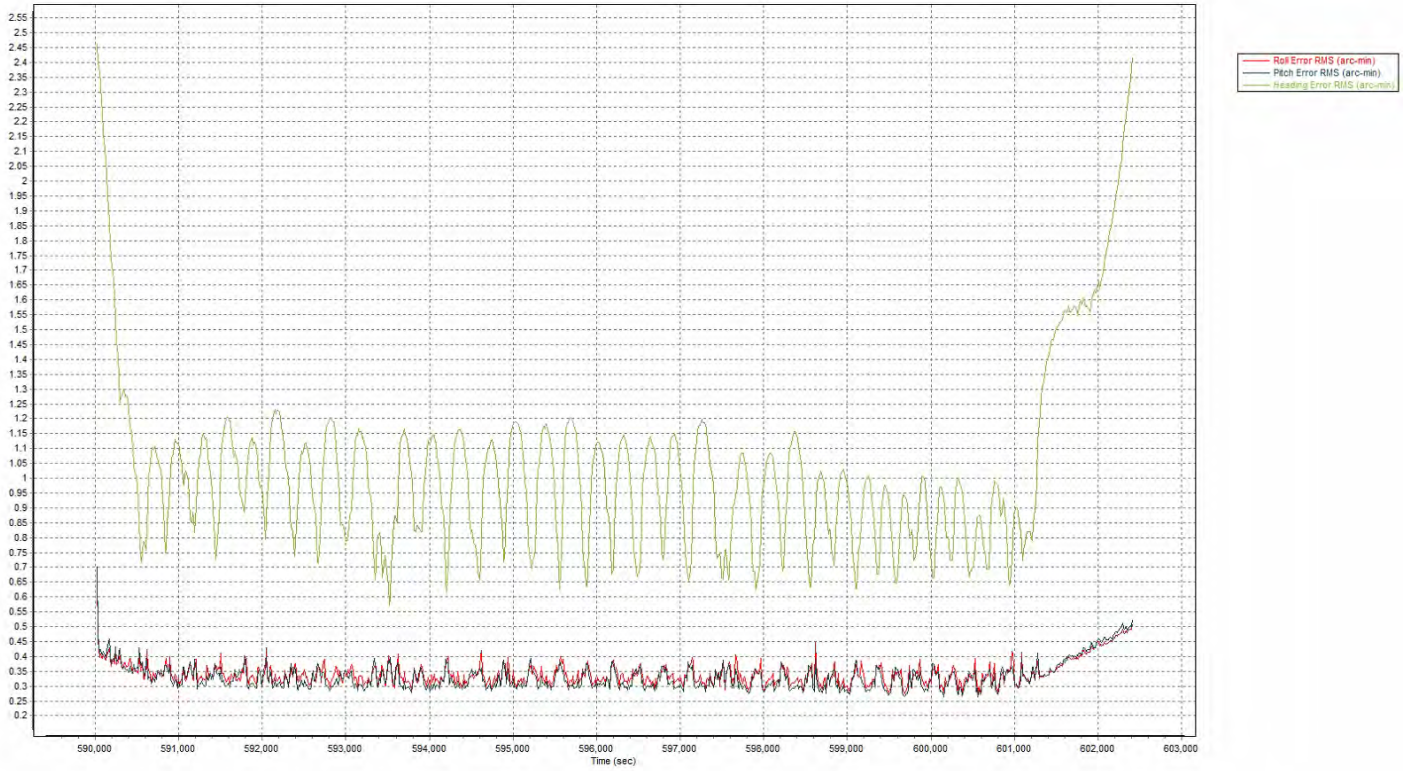

Estimated StdDev (m)
0.040
0.035
0.030
0.025
0.020
0.015
0.010
592000
Week 1889
594000
596000
598000
600000
602000
GPS Time (TOW, GMT zone)
East
North
Height
Trace


Separation (m)
1.0
0.8
0.6
0.4
0.2
-0.0
-0.2
-0.4
-0.6
-0.8
-1.0
592000
Week 1889
594000
596000
598000
600000
602000
GPS Time (TOW, GMT zone)
East
North
Up


PDOP
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
592000
Week 1889
594000
596000
598000
600000
602000
GPS Time (TOW, GMT zone)
PDOP


Num Sats
24
22
20
18
16
14
12
10
8
6
4
2
0
592000
Week 1889
594000
596000
598000
600000
602000
GPS Time (TOW, GMT zone)
Too Few
Minimal
Acceptable
Good
Exceptional


North Position Error RMS (m)
East Position Error RMS (m)
Down Position Error RMS (m)
Time (sec)


Roll Error RMS (arc-min)
Pitch Error RMS (arc-min)
Heading Error RMS (arc-min)
Time (sec)

Flight Log

Page 1 of 2

Richard Crouse & Associates Phone: (301)846-4865 Fax: (301)846-4868

LiDAR FLIGHT LOG

Hobbs Finish	294.2		3/26/2016			LiDAR Type	Riegl 680i	Altitude AMT (ft)	1600	Air Temp. °C	11
Hobbs Start	289.1		63868	FW		Scan Rate(1/s)	185	Speed (kts)	125	Dew Point °C	-1
Total	5.1	No. of Lifts 1	MG	NP	MTA ZONE	Laser PRR (KHZ)	400	PPSM	8	Wx Station	KABE
Itinerary	KHFD-KHFD		UTC-Local	-4	2	Laser FOV °deg	60	RCD Imagery	No	GPS Type	N.A
Project Location:			Applanix Data (UTC)		No. of Files	GPS Base station	NO	NGS Point	No	Antenna Type	N.A
Allentown, PA			Start	End	56	Start/End	-	NGS PID Name	N.A	Ant. Ht. to ARP	N.A
			18:48	00:13		Point Desc.	Used CORS KPI1 (KeyNET)				

Line/Dir	Record#	UTC Start	UTC End	Flight Altitude ASL (ft)	Aircraft Speed (kts)	PDOP	Turbulence S/M/T	Remarks	RC&A Job Number
35S	1	19:59	20:00	2000	111	1.3	S	CORS KPI1	27703MD
37N	2	20:04	0:00	1998	116	1.2	S		
33S	3	20:09	20:10	2088	127	1.1	S		
32N	4	20:14	20:15	2214	125	1.1	S		
31S	5	20:19	20:20	2126	115	1.0	S		
30N	6	20:24	20:26	2214	124	1.1	S		
29S	7	20:28	20:30	2061	110	1.1	S		
28N	8	20:33	20:36	2379	130	1.1	S		
27S	9	20:39	20:41	2025	112	1.1	S		
26N	10	20:44	20:47	2037	123	1.0	S		
25S	11	20:54	20:56	2121	114	1.1	S		
24N	12	20:59	21:02	2308	123	1.3	S		
23S	13	21:05	21:07	2088	109	1.3	S		
22N	14	21:10	21:13	2524	119	1.3	S		
21S	15	21:16	21:19	2124	118	1.3	S		
20N	16	21:21	21:24	2316	119	1.1	S		
19S	17	21:27	21:30	2283	123	1.1	S		
18N	18	21:32	21:35	2180	124	1.1	S		
17S	19	21:37	21:40	2072	122	1.1	S		
16N	20	21:42	21:45	2111	127	1.0	S		
15S	21	21:48	21:50	2089	120	1.0	S		
14N	22	21:53	21:55	2177	123	1.1	S		
13S	23	21:01	22:04	2070	118	1.1	S		
12N	24	22:06	22:09	2140	126	1.2	S		

Page 1 of 2

Richard Crouse & Associates

Phone: (301)846-4865 Fax: (301)846-4868

LiDAR FLIGHT LOG

Hobbs Finish	294.2		3/26/2016			LiDAR Type	Riegl 680i	Altitude AMT (ft)	1600	Air Temp. °C	11
Hobbs Start	289.1		63868	FW		Scan Rate(1/x)	185	Speed (kts)	125	Dew Point °C	-1
Total	5.1	No. of Lifts 1	MG	NP	MTA ZONE	Laser PRR (KHZ)	400	PPSM	8	Wx Station	KABE
Itinerary	KHFD-KHFD		UTC-Local	-4	2	Laser FOV °deg	60	RCD Imagery	No	GPS Type	N.A
Project Location:			Applanix Data (UTC)		No. of Files	GPS Base station	NO	NGS Point	No	Antenna Type	N.A
Allentown, PA			Start	End	56	Start/End	-	NGS PID Name	N.A	Ant. Ht. to ARP	N.A
			18:48	00:13		Point Desc.	Used CORS KPI1 (KeyNET)				

Line/Dir	Record#	UTC Start	UTC End	Flight Altitude ASL (ft)	Aircraft Speed (kts)	PDOP	Turbulence S/M/T	Remarks	RC&A Job Number
11S	25	22:12	22:14	2048	119	1.2	S		
10N	26	22:17	22:19	2087	118	1.1	S		
9S	27	22:21	22:24	2145	121	1.0	S		
8N	28	22:26	22:28	2106	123	1.0	S		
7S	29	22:30	22:32	2152	122	1.0	S		
6N	30	22:34	22:35	2052	125	1.0	S		
5S	31	22:38	22:39	2168	118	1.0	S		
4N	32	22:41	22:42	2098	110	1.0	S		
3S	33	22:45	22:46	2088	115	1.0	S		
2N	34	22:49	22:50	2220	125	1.0	S		
1S	35	22:53	22:53	2135	113	1.0	S		
3N	36	22:56	22:57	2176	123	1.1	S	Caliberation line	
36NE	37	23:01	23:05	2195	120	1.2	S	Cross Strip Line	

Notes and Comments:

Rev3 -02/07/2013

Page 2 of 2

Appendix C

Imagery Flight Logs

There was one total lifts. Flight logs are found on the following pages.

Mar 30, 2016-A (N59848)

RC&A Richard Crouse & Associates

Flight Log

		HOBBS	Sensor Type	Serial#/Type			Antenna Type		Office
Date	3/30/16	Finish 2780.7			GNSS Base	NONE	ARP Height (m)		MD
Aircraft N#	59848	Start 2777.8	Digital	DMC2-017			Airport/Site		
Pilot	RS	TOTAL 2.9			Laser PRR(KHZ)			Beginning Ending	
Operator	TC	#Lifts 1	Cam Mount	PAV100	Aircraft Alt (ft)		Air Temp °C		Archive Drive
Itinerary	FDK-FDK	Flight Type	ABGPS/IMU	YES	Speed (kts)		Dew Pt.°C		Proc. Drive
		Production	#Applanix Files	SPAN	Laser PPSM		AWOS Station		PAGE NO.
					UTC-Local Time diff.	-4			1 of 1

CamFrame# Record#	Line # Flt. Dir	Drift	Altitude (ft)	Time Start-Stop	Events Start-Stop	Photo ID Start-Stop	Line Status	Turb	Film Type/ Exp/Remarks	RCA Job#	Client
	1N		4196	14:32-14:32	0-6	1-7	C	S		27702MD	QSI
	2S		4190	14:36-14:36	7-17	11-1	C	S		27702MD	QSI
	3N		4167	14:39-14:30	18-28	1-11	C	S		27702MD	QSI
	4S		4150	14:43-14:44	29-41	13-1	C	S		27702MD	QSI
	5N		4163	14:47-14:49	42-61	1-20	C	S		27702MD	QSI
	6S		4157	14:52-14:54	62-85	24-1	C	S		27702MD	QSI
	7N		4147	14:57-14:58	86-109	1-24	C	S		27702MD	QSI
	8S		4134	15:01-15:08	110-135	26-1	C	S		27702MD	QSI
	9N		4131	15:06-15:08	136-159	1-24	C	S		27702MD	QSI
	10S		4150	15:11-15:13	160-186	27-1	C	S		27702MD	QSI
	11N		4193	15:16-15:19	187-215	1-29	C	S		27702MD	QSI
	12S		4183	15:22-15:24	216-242	27-1	C	S		27702MD	QSI
	13N		4170	15:27-15:29	243-267	1-25	C	S		27702MD	QSI
	14S		4216	15:31-15:33	268-292	25-1	C	S		27702MD	QSI
	15N		4265	15:37-15:38	293-317	1-25	C	S		27702MD	QSI
	16S		4212	15:42-15:43	318-336	19-1	C	S		27702MD	QSI
	17N		4160	15:47-15:48	337-351	1-15	C	S		27702MD	QSI
	18S		4092	15:51-15:52	352-360	9-1	C	S		27702MD	QSI
	-										

Supply Cassette	Take-up Cassette	Film/Emulsion	Exp. Date	

Maryland | South Carolina | Maine | Kansas | www.richardcrouse.com

Line Status C=Complete, P=Partial, X=Reject
Turbulence S=Smooth, M=Moderate, T=Turbulent, VT=Very Turbulent
Use UTC for LiDAR and DMC. Local Time for Film

Appendix D

Aerotriangulation Report

Allentown

Aerial Triangulation Report

Prepared for

Photo Science, Inc. Project No. 27136

September 06, 2016

Produced By:

523 Wellington Way, Suite 375
Lexington, KY 40503

Table of Contents

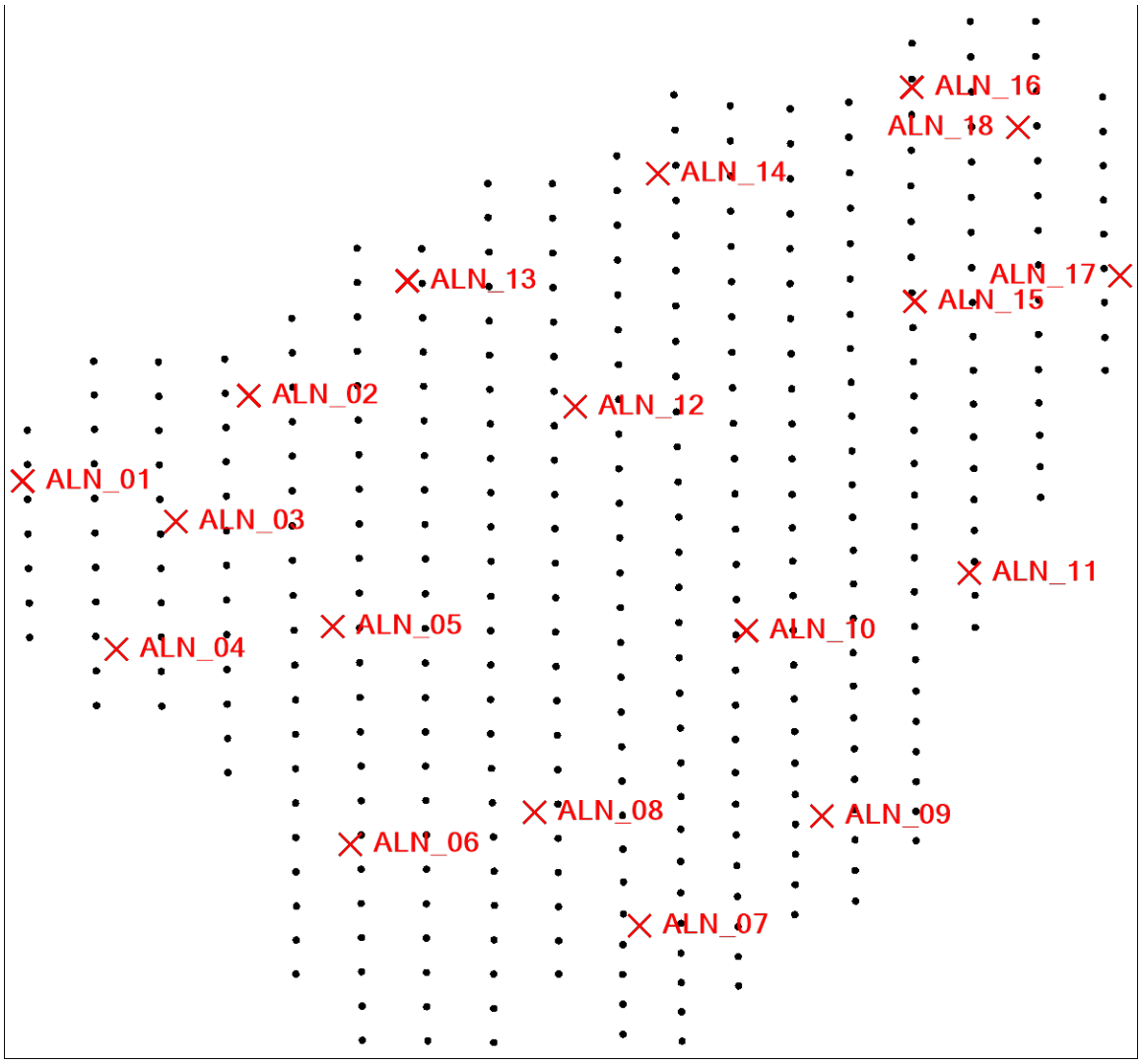
1.0 Project Details

The scope of this project consists of providing color aerial photography, ground control, aerial triangulation, color digital orthos.

2.0 Aerial Photography

A total of 18 flight lines of RGB photography, consisting of 361 stereo frame photographs, were taken at an altitude of 5,150 feet above ground level for a 1"=858' photo scale. The photography was obtained on September 24, 2015 using an Intergraph DMCIIe-230 digital mapping camera (serial number 23522) having a focal length of 92.0064.
Following is a list of the flight lines and frames:

Flight Line Number	Frame Numbers
1	1 - 7
2	1 - 11
3	1 - 11
4	1 - 13
5	1 - 20
6	1 - 24
7	1 - 24
8	1 - 26
9	1 - 24
10	1 - 27
11	1 - 29
12	1 - 27
13	1 - 25
14	1 - 25
15	1 - 25
16	1 - 19
17	1 - 15
18	1 - 9
18 flight lines	361 frames



● Used Image | ● Un-Used Image | ● Tie-Control

X Control | X Control, Horizontal Only | X Control, Vertical Only | X Check Points

3.0 Control

The ground control was established by Photo Science, Inc. using GPS technology. Please refer to the ground control report for more specific detail. The X, Y, Z coordinates of each photo center is included in the final AT adjustment. A total of 18 photo identification control points were used. The location of the control points are shown on the photo center diagram.

All statistical data for the control points are given in the Aerial Triangulation section.

```
See attached Control_RMSE file:
27136_Control_RMSE.txt
```

Ground Control Points

Point ID	X	Y	Z
ALN_01	2577570.850	469597.020	411.810
ALN_02	2586032.530	472786.000	380.260
ALN_03	2583295.070	468088.980	323.830
ALN_04	2581080.340	463313.250	404.620
ALN_05	2589166.450	464165.740	320.310
ALN_06	2589813.370	456030.810	289.020
ALN_07	2600618.920	452988.260	491.730
ALN_08	2596701.240	457224.940	400.360
ALN_09	2607448.430	457082.890	707.800
ALN_10	2604625.840	464012.510	350.540
ALN_11	2612946.090	466166.890	513.470
ALN_12	2598221.070	472369.330	355.720
ALN_13	2591950.490	477074.670	393.140
ALN_14	2601305.000	481083.820	350.340
ALN_15	2610917.810	476307.260	358.680
ALN_16	2610807.880	484307.750	362.680
ALN_17	2618593.990	477264.320	299.860
ALN_18	2614775.810	482806.550	349.900

4.0 Aerial Triangulation Measurement

The measurement of the pass points, flight ties and control data was performed on Intergraph's ISAT, version 100.0, automated aerotriangulation system. Pass points were selected automatically using a sophisticated auto correlation algorithm.

All images were from the DMC mapping camera has a scan resolution of 12 microns.

5.0 Aerial Triangulation Adjustment

The adjustment of the measurements was performed using a robust aerotriangulation software package on softcopy photogrammetric workstations. The final adjustment of the block was accomplished by using a rigorous simultaneous least squares bundle adjustment. The general procedure is to remove all blunders from the data using automatic blunder detection. The bundle adjustment is then run with minimal ground control to test the photogrammetric measurements for consistency. Next, the full ground control data set, including the ABGPS data, is added to the adjustment holding the horizontal control very loose and the vertical control very tight. Since horizontal control errors can affect the vertical control but not vice-versa, we can detect errors in the vertical control. The horizontal control is then tightened and the effect on the vertical control and the photogrammetric residuals are inspected. The final adjustment makes sure that all of the measurements are in balance with each other and properly represent the actual conditions.

The following Weights, or Estimated Standard Errors, were used in the final adjustment:

Photogrammetric measurements:	<5 microns
Horizontal Control:	0.25ft
Vertical Control:	0.25ft
Tie Control	0.50ft
IMU Control	0.05deg
ABGPS Horizontal Control	0.30ft
ABGPS Vertical Control	0.30ft

The Estimated Standard Errors are exactly what the name implies. This shows how close the measurements are to their actual value. The above values were chosen based upon previous experience, requested specifications, and industry standards.

6.0 Aerial Triangulation Results

The aerial triangulation results are given in three sections: airborne GPS (ABGPS), photogrammetric measurements, and ground control. The following parameters were used during the A/T data reduction:

```
PhotoT Triangulation Options

Adjustment Mode       : Absolute
Precision Computation : Enabled
Error Detection       : Enabled
Camera Calibration    : Disabled
Self-Calibration      : Disabled
Given EO/GPS          : Enabled
Antenna Offsets       : Disabled
GPS Shift/Drift Correction : Enabled
INS Shift/Drift Correction : Disabled


Parameters

                  Parameter X/Omega Y/Phi Z/Kappa    XY
                RMS Control   0.176 0.238   0.044 0.209
                  RMS Check
                 RMS Limits   1.000 1.000   1.000
         Max Ground Residual   0.334 0.503   0.092
             Residual Limits   2.000 2.000   2.000
         Mean Std Dev Object   0.057 0.055   0.142
          RMS Photo Position   0.111 0.128   0.119
          RMS Photo Attitude   0.008 0.004   0.004
 Mean Std Dev Photo Position   0.107 0.110   0.059
 Mean Std Dev Photo Attitude   0.002 0.002   0.001
```

```
Key Statistics

     Sigma:    1.7  um
     Number of iterations:    4
     Degrees of Freedom: 22859

Solution Successful.


Current Count

     Control Points Used:     18
     Check Points Used:  0
     Photos Used:   361
      Photos Not Used:   0
     Image Points Used:  17428
```

6.1 ABGPS Results

See attached Airborne GPS RMSE file: 27136_ABGPS.txt

6.2 Least Squares Ground Residuals

The observations in a simultaneous block adjustment are the photo or model points, and the ground control. The least squares residual for an observation is how much the measured value is moved during the adjustment.

7.0 Control and Tie Point Problems

None

8.0 Delivery Data/Materials

- 27136_CTL.txt-Control and Residuals
- 27136_ ABGPS.txt-ABGPS and Residuals
- 27136AT_Report.doc-A/T report

9.0 Aerotriangulation Approval

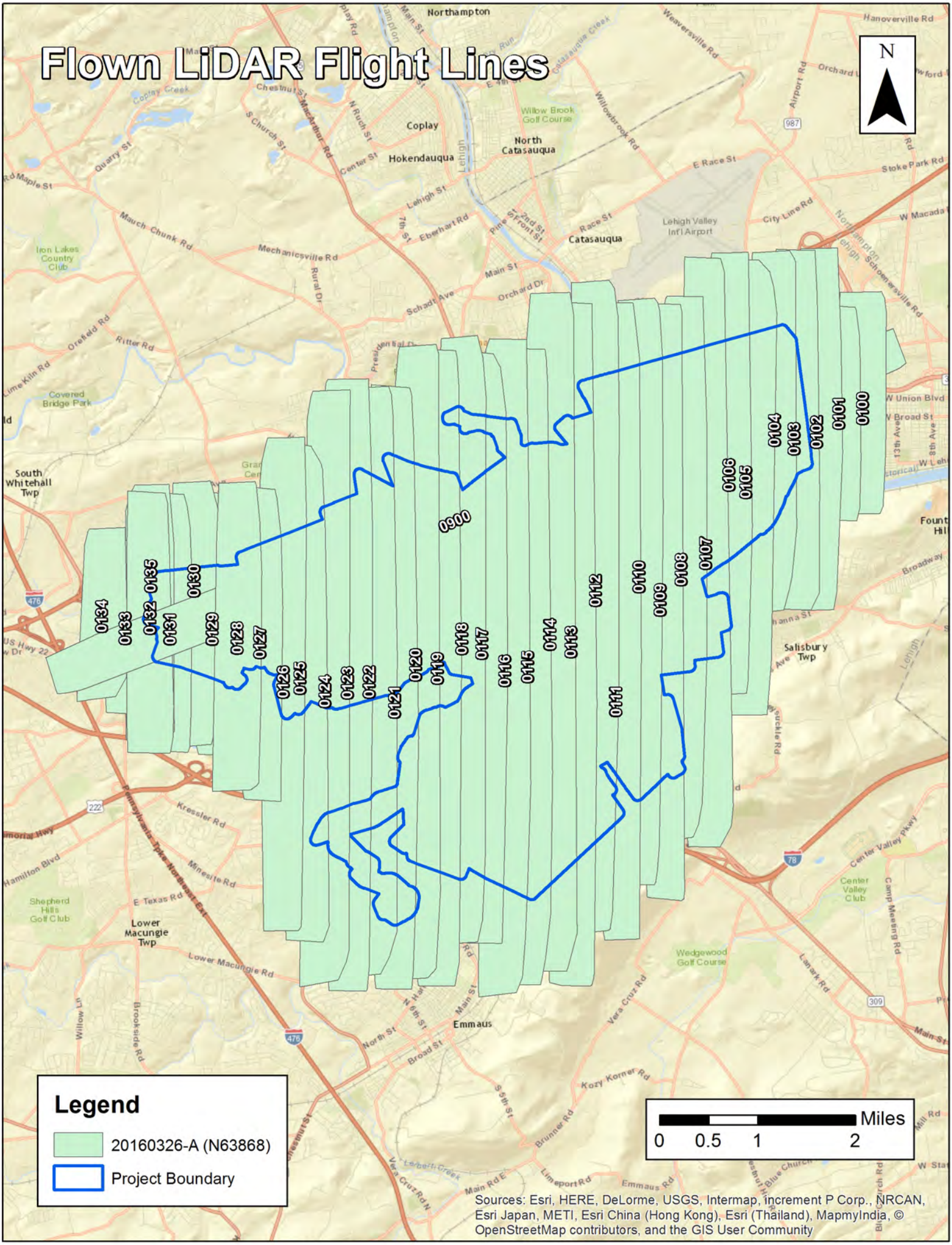
9.1 Aerotriangulation Results Summary

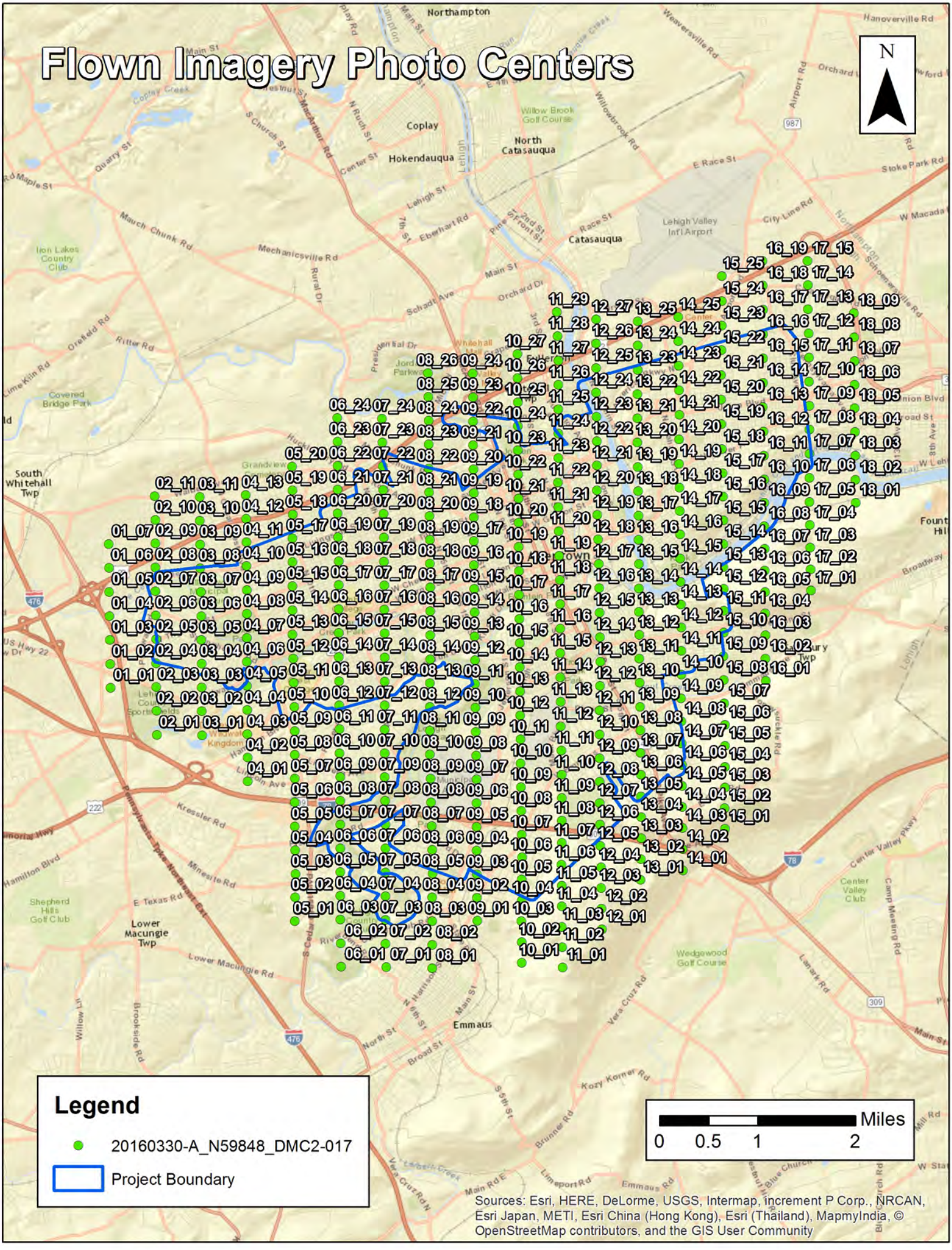
The aerial triangulation results for Allentown are summarized in the following table:

Parameter	Results
Sigma Naught	1.7
Number of Images	361
Total Points	18
Image Measurements	17428
Average # of Points per Image	48
Control Points	18 Horz/Vert Photo ID Point
Point Weighting	Photo Measurements – <5 microns ABGPS – 0.30ft Ground Control – 0.25ft
Final Pixel RMSE	0.209 pixels
Ground Control RMSE's	X –0.176 feet Y –0.238 feet Z –0.044 feet

Appendix E

Flight Maps


Flown LiDAR Flight Lines
N
0900
0100
0101
0102
0103
0104
0105
0106
0107
0108
0109
0110
0111
0112
0113
0114
0115
0116
0117
0118
0119
0120
0121
0122
0123
0124
0125
0126
0127
0128
0129
0130
0131
0132
0133
0134
0135
Northampton
Coplay
Hokendauqua
North Catasauqua
Catasauqua
Lehigh Valley Int'l Airport
South Whitehall Twp
Salisbury Twp
Lower Macungie Twp
Emmaus
Legend
20160326-A (N63868)
Project Boundary
Miles
0 0.5 1 2
Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), MapmyIndia, © OpenStreetMap contributors, and the GIS User Community


Flown Imagery Photo Centers
N
Legend
20160330-A_N59848_DMC2-017
Project Boundary
Miles
0 0.5 1 2
Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

Appendix F

Survey Report

6/05/16

Survey Report of LiDAR Calibration & Quality Control Points & Orthoimagery Calibration & Quality Control Points

Allentown, PA 7.5cm
GSD Ortho & QL1 LiDAR
USGS Contract: G16PC00016
USGS Task Order: G16PD00361

Presented to:

USGS
science for a changing world

Presented By:

Together With:

HRG
Herbert, Rowland & Grubic, Inc.
Engineering & Related Services
AN EMPLOYEE-OWNED COMPANY

As Sub Consultant to Quantum Spatial

Introduction

Quantum Spatial, Inc was contracted by USGS under task order G16PD00361 to Survey LiDAR calibration and quality control points as well as orthoimagery calibration and quality control point in support of Allentown, PA 7.5cm
GSD Ortho & QL1 LiDAR. Subsequently, Quantum Spatial contracted HRG Inc. to perform the field surveys and provide the resulting point coordinates. This is the report of the technical approach used and detail of each point surveyed.

Project Area

The Project Area, shown in the figure below, consists of approximately 75 square kilometers.

See attached Maps

Technical Approach to Land Cover Validation Point Selection

Referencing ASPRS Positional Accuracy Standards for Digital Geospatial Data (Edition 1, Version 1.0, - November, 2014) table C.1 Recommended Number of Checkpoints based on Area, Quantum Spatial calculated that <number> Non-Vegetated Vertical Assessment (NVA) and <number> Vegetated Vertical Assessment (VVA) points are required for this project area.

To ensure that checkpoints were distributed generally proportionate among the various vegetated land cover types, Quantum Spatial used existing USGS Land Cover data to divide both the NVA and VVA categories among the various types, calculating the approximate number of required points in each representative type proportionate to the total project area. The resulting point classes are detailed below:

NVA Class	20 of Points
Bare Earth	4
Urban Area	16

VVA Class	# of Points
Tall Weeds/Crops	2
Brush/Low Trees	1
Forested	2

Given that approximately 1/2 of the NVA check points should also be used for horizontal accuracy testing, but that it is commonly understood that good vertical check points do

not generally make for good horizontal check points, Quantum Spatial has required that 22 horizontal check points shall be used for this project, whether they are used for NVA validation, or are entirely separate. These locations have been reported under their own chapter in this report.

Quantum Spatial has adopted the philosophy that each vegetative class must be well distributed throughout the project area. While points in varying classes may be near to one another, points of a single vegetative class may not. Proposed point locations are selected with this distribution methodology in mind.

Survey Accuracy Requirements

Given that the survey accuracy of calibration and quality control check points should be 3 times more accurate than the required accuracy of the data set, Quantum Spatial requires that calibration and NVA points be better than 6.5 centimeters at 95% confidence, both horizontally and vertically, and that VVA points be better than 9.8 centimeters at 95% confidence, both horizontally and vertically. The surveyed accuracy of each point must be determined through redundant measurements and/or network adjustment using procedures and methodologies that reliably and consistently result in the aforementioned accuracies. The accuracy of each point is reported at the 95% confidence level, meaning that if the point were measured 20 times, statistically it would fall within the reported accuracy 19 times.

Due to variances in reference control accuracy and adjustment, Quantum Spatial requires that the survey methodology used be explained, so that it can be repeated if necessary.

Field Survey Methodology

Date Range:
April- 25 -2016 to May-3-2016

Equipment Used:
Trimble R10 GNSS receivers and a Trimble S8 Robotic Total Station

GNSS Methodology:
Each point was measured using the KeyNet GPS VRS network. Each point was measured twice, once for 3 minutes and once for 30 seconds. Sufficient time was allowed between observations to ensure variance in satellite constellations. For forested points, a pair of

inter-visible survey control points were set and observed using the same procedure as above. A Trimble S8 Robotic total station was then used to occupy this survey control and observe the forested point.

Overall Project Accuracy Statement

All point coordinates have been reported in the North American Datum of 1983 (NAD83 2011), PA State Plane South Zone (3701) in US survey feet. Elevations are relative to the North American Vertical Datum of 1988 (NAVD 88) which were derived using Geoid 12A and are reported in US Survey Feet.

Calibration Points
Average Horizontal RMSE at the 95% confidence level is 0.0127 Meters.
Average Elevation RMSE at the 95% confidence level is 0.0168 Meters.
Average 3 dimensional RMSE at the 95% confidence level is 0.0211 Meters

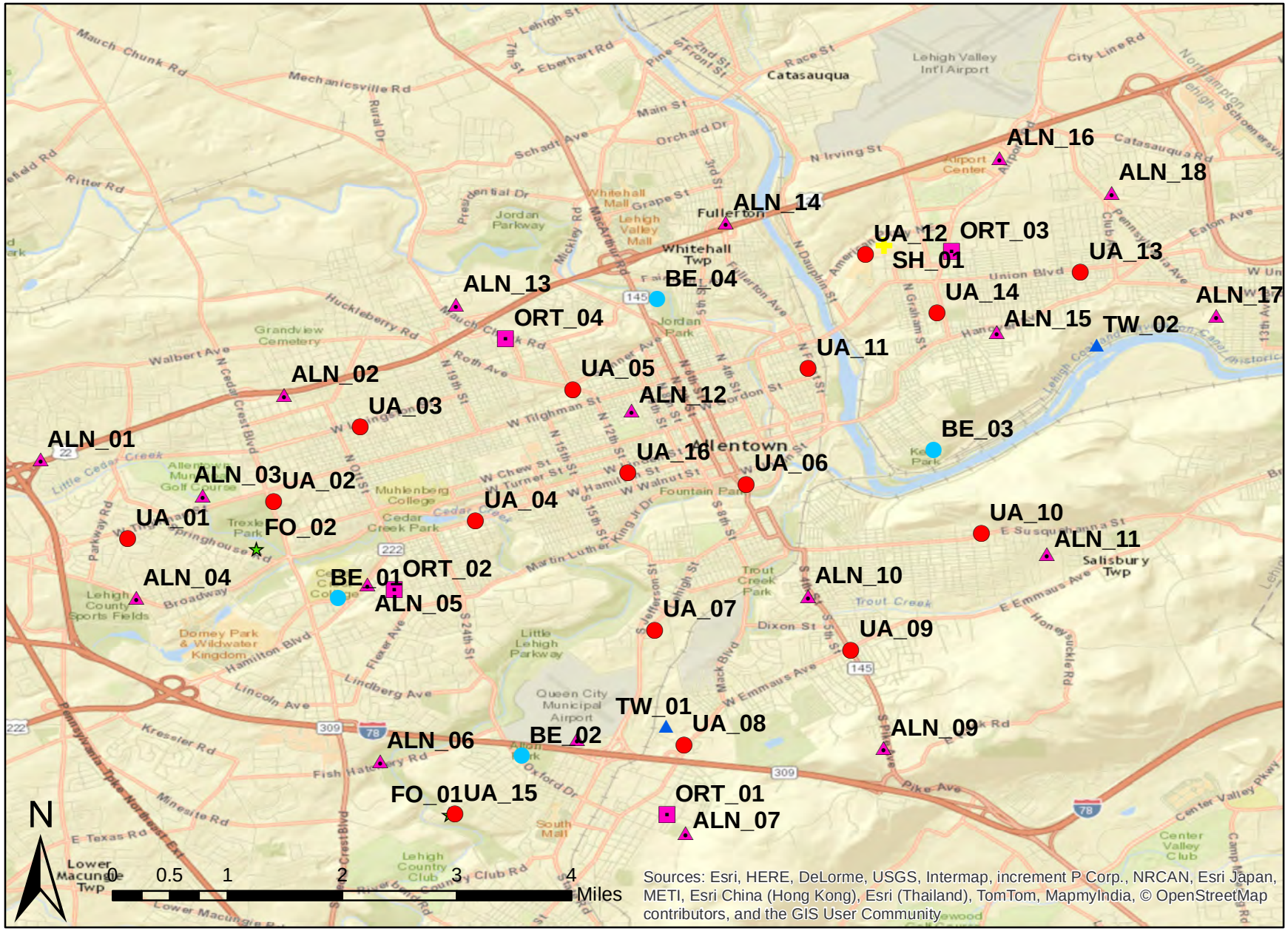
NVA Points
Average Horizontal RMSE at the 95% confidence level is 0.0125 Meters.
Average Elevation RMSE at the 95% confidence level is 0.0155 Meters.
Average 3 dimensional RMSE at the 95% confidence level is 0.0199 Meters.

VVA Points
Average Horizontal RMSE at the 95% confidence level is 0.0217 Meters.
Average Elevation RMSE at the 95% confidence level is 0.0279 Meters.
Average 3 dimensional RMSE at the 95% confidence level is 0.0353 Meters.

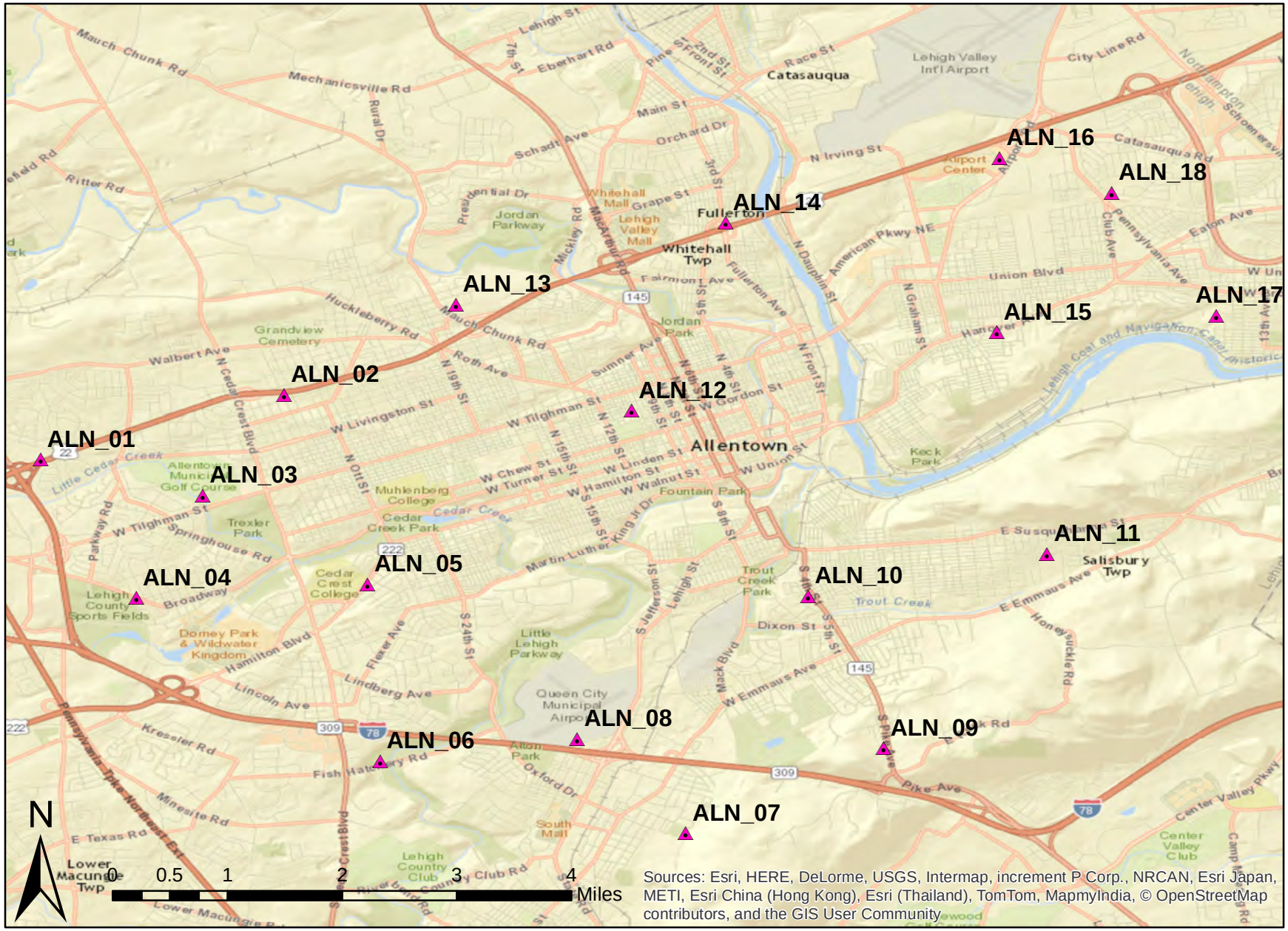
GPS PROJECT SUMMARY

Project	Allentown, PA 7.5cm GSD Ortho & QL1 LiDAR
Location	Allentown, PA
Task Order Number	G16PD00361
HRG Project Number	7494.0425
Date	6-6-16
Person Responsible for GPS Calculations	Zach Lupold , LSIT
Coordinate System	State Plane (3701 PA South)
Vertical Datum	NAVD 88
Units	US Survey Feet
Geoid Model	Geoid 12A
GPS Hardware	Trimble R10
Crew Size	1
Observation Methodology	VRS
GPS Software Employed	Trimble Business Center

Task Order # G16PD00361
Allentown Ortho Control and Lidar QA Points

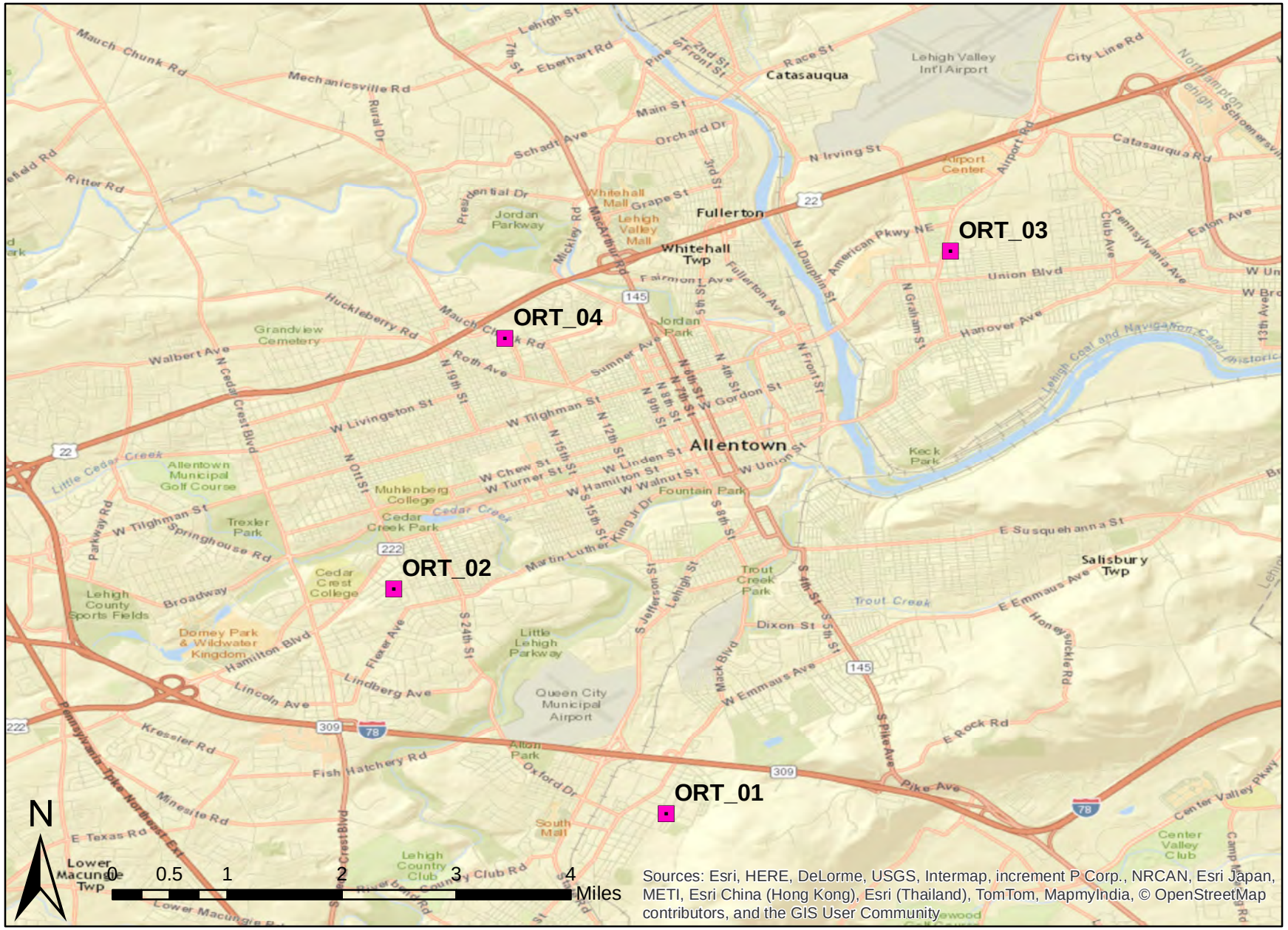


Task Order # G16PD00361
Allentown ALN Points



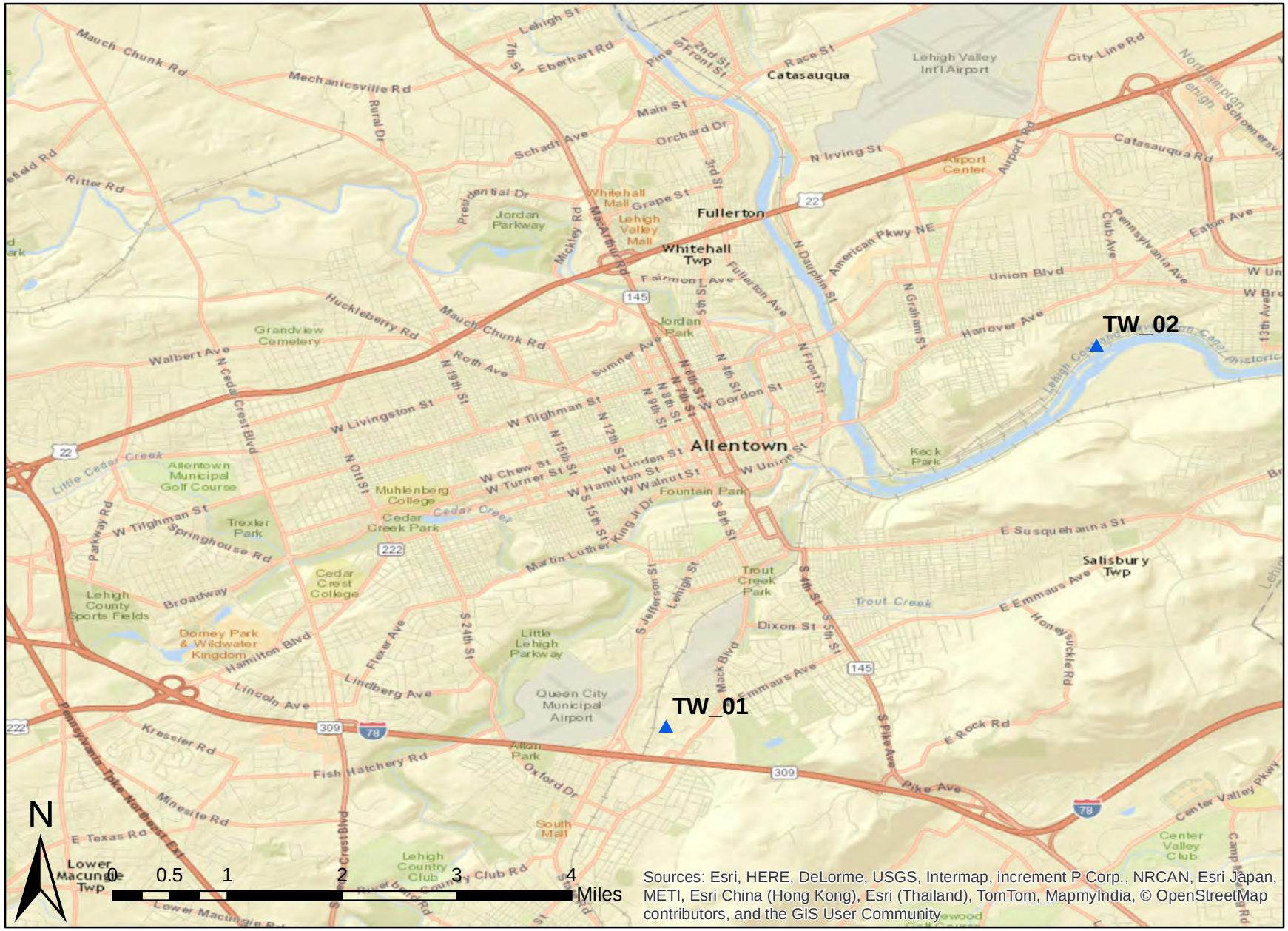
Task Order # G16PD00361
Allentown FO Points

Task Order # G16PD00361
Allentown ORT Points

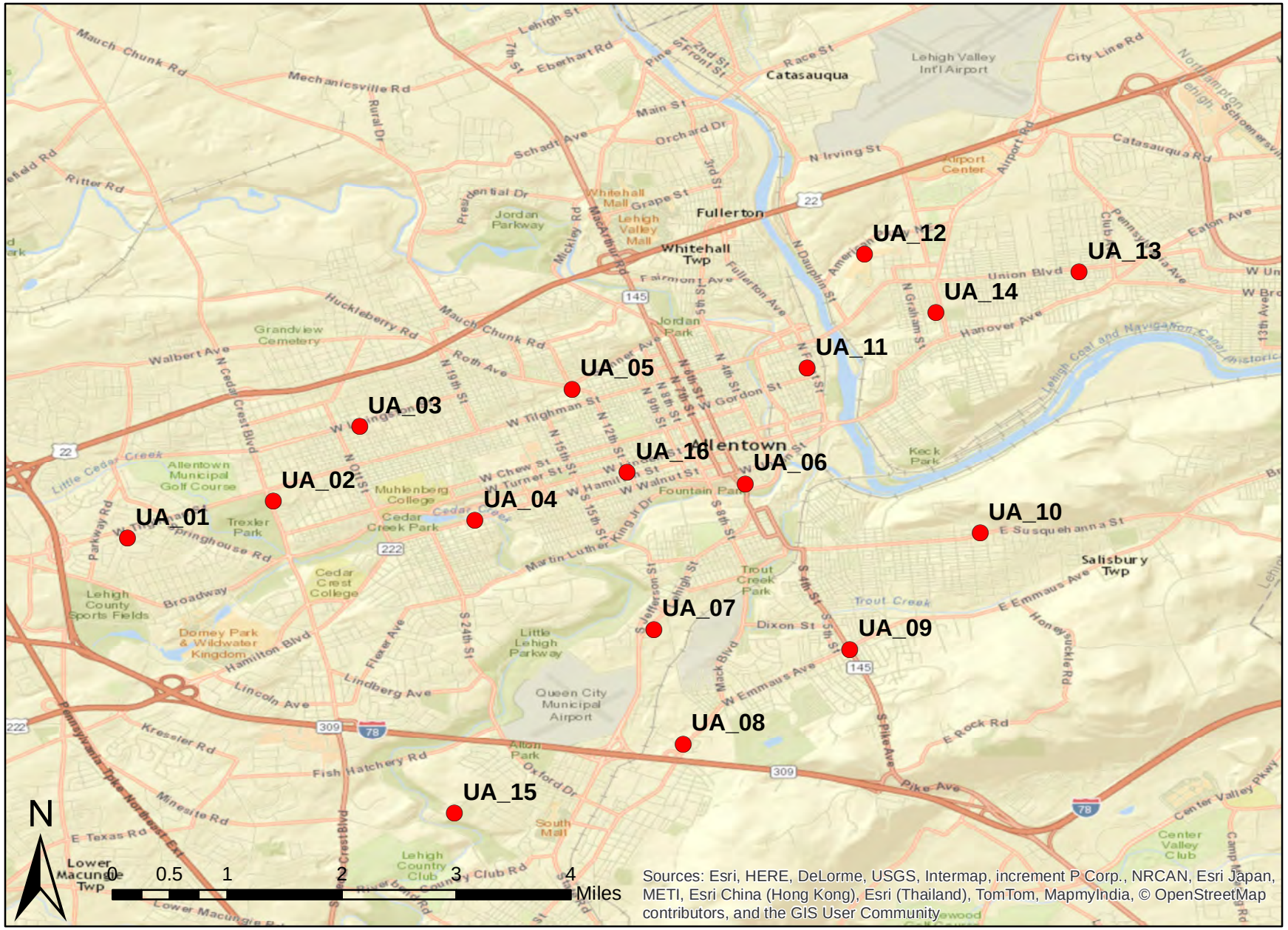


Task Order # G16PD00361
Allentown SH Points

Task Order # G16PD00361
Allentown TW Points



Task Order # G16PD00361
Allentown UA Points



Final Coordinates
PA State Plane South 3701, US Survey Feet

Survey ID	NORTHING	EASTING	ELEVATION	DESCRIPTION
ALN_01	469597.02	2577570.85	411.81	PAINT STRIPE
ALN_02	472786	2586032.53	380.26	PAINT STRIPE
ALN_03	468088.98	2583295.07	323.83	PAINT STRIPE
ALN_04	463313.25	2581080.34	404.62	PAINT STRIPE
ALN_05	464165.74	2589166.45	320.31	PAINT STRIPE
ALN_06	456030.81	2589813.37	289.02	PAINT ARROW
ALN_07	452988.26	2600618.92	491.73	PAINT STRIPE
ALN_08	457224.94	2596701.24	400.36	PAINT STRIPE
ALN_09	457082.89	2607448.43	707.8	PAINT ARROW
ALN_10	464012.51	2604625.84	350.54	STOP BAR CORNER
ALN_11	466166.89	2612946.09	513.47	VAULT CORNER
ALN_12	472369.33	2598221.07	355.72	PAINT STRIPE
ALN_13	477074.67	2591950.49	393.14	PAINT ARROW
ALN_14	481083.82	2601305	350.34	PAINT STRIPE
ALN_15	476307.26	2610917.81	358.68	PAINT TRIANGLE
ALN_16	484307.75	2610807.88	362.68	PAINT STRIPE
ALN_17	477264.32	2618593.99	299.86	PAINT STRIPE
ALN_18	482806.55	2614775.81	349.9	PAINT STRIPE
BE_01	463505.75	2588159.14	329.96	BARE EARTH
BE_02	456416.75	2594774.56	376.62	BARE EARTH
BE_03	470848.5	2608849.11	341.49	BARE EARTH
BE_04	477516.38	2598983.57	263.41	BARE EARTH
FO_01	453627.28	2592314.88	385.72	FOREST
FO_02	465699.64	2585245.67	322.77	FOREST
ORT_01	453833.28	2599942.61	429.34	PAINT STRIPE
ORT_02	463939.7	2590119.11	348.62	SIDEWALK CORNER
ORT_03	479964.78	2609238.22	339.76	PAINT ARROW
ORT_04	475560.33	2593730.94	392.18	SIDEWALK CORNER
SH_01	480182.37	2606862.22	344.88	SHRUBS
TW_01	457923.01	2599800.66	382.75	TALL GRASS
TW_02	475831.58	2614432.47	245.51	TALL GRASS
UA_01	466032.12	2580720.31	427.87	PAINT ARROW
UA_02	467852.94	2585786	364.25	PAINT STRIPE
UA_03	471368.51	2588730.8	392.22	PAINT STRIPE
UA_04	467152.92	2592880.4	277.16	PAINT ARROW
UA_05	473289	2596136.95	311.36	PAINT STRIPE
UA_06	469095.62	2602320.63	263.47	PAINT STRIPE
UA_07	462308.97	2599289.54	347.41	PAINT ARROW
UA_08	457060.45	2600449.33	402.12	PAINT ARROW

Final Coordinates
PA State Plane South 3701, US Survey Feet

UA_09	461564.94	2606191.84	368.3	PAINT STRIPE
UA_10	467031.72	2610627.05	502.68	PAINT STRIPE
UA_11	474485.57	2604363.27	288.67	PAINT STRIPE
UA_12	479748.66	2606220.36	339.2	PAINT STRIPE
UA_13	479150.19	2613781.14	359.7	PAINT ARROW
UA_14	477137.78	2608800.36	314.28	PAINT STRIPE
UA_15	453671.3	2592508.24	395.83	PAINT STRIPE
UA_16	469493.96	2598164.83	390.11	PAINT STRIPE

HRG
Herbert, Rowland & Grubic, Inc.
Engineering & Related Services
AN EMPLOYEE-OWNED COMPANY
369 East Park Drive
Harrisburg, Pa,17111
717-564-1121

GPS CONTROL SURVEY
FIELD DATA SHEET

JOB REFERENCE	POINT ID:	ALN_01
Allentown, PA (USGS)	Proj. No.:	7494.0425

STATE	PA	COUNTY	LEHIGH	QUAD:	Allentown West (PA)

OPERATOR	ZJL

NAD83(2011) PA SPC SOUTH ZONE NAVD88 SURVEY FT.

Northing	469597.020	Elevation
Easting	2577570.850	411.810

RECEIVER MODEL	TRIMBLE R10
RECEIVER S/N	5413461432

SESSIONS	DATE:	ObsA	Obs B
VRS	DAY OF YEAR	116	124

	Obs A	ObsB		
START TIME	12:37	09:57		U.T.C.
END TIME	12:40	09:58	X	LOCAL

ANTENNA HEIGHT (SLANT)				
MTRS/FT	2.00 Meters			
	MEASURED	X	FIXED HGT.	

ANTENNA HEIGHT (ARP)				
MTRS/FT	2.000 Meters			
	MEASURED	X	FIXED HGT	

ANTENNA			
RADIUS (M)			
Antenna Serial #	5413461432		
Antenna Type	TRM R10	Trimble Integrated Antenna	

TOP OF MONUMENT IS:		x	FLUSH
METERS/FEET			ABOVE GROUND
METERS/FEET			BELOW GROUND

Parking Stripe Intersecton

	AERIAL TARGET		PHOTO I.D.
	PUB. BENCH MARK	X	NEW CONTROL
	PUB. CONTROL		BASE STATION

PHOTO

PHOTO:

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GPS CONTROL SURVEY
FIELD DATA SHEET

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JOB REFERENCE
Allentown, PA (USGS)

POINT ID:	ALN_02
Proj. No.:	7494.0425

STATE	PA	COUNTY	LEHIGH	QUAD:	Allentown West (PA)

OPERATOR	ZJL

NAD83(2011) PA SPC SOUTH ZONE NAVD88 SURVEY FT.

Northing	472786.000
Easting	2586032.530

Elevation
380.260

RECEIVER MODEL	TRIMBLE R10
RECEIVER S/N	5413461432

SESSIONS	DATE:	ObsA	Obs B
VRS	DAY OF YEAR	116	124

	Obs A	ObsB		
START TIME	12:59	09:41		U.T.C.
END TIME	13:02	09:41	X	LOCAL

ANTENNA HEIGHT (SLANT)				
MTRS/FT	2.000 Meters			
	MEASURED	X	FIXED HGT.	

ANTENNA HEIGHT (ARP)			
MTRS/FT	2.000 Meters		
	MEASURED	X	FIXED HGT

ANTENNA			
RADIUS (M)			
Antenna Serial #	5413461432		
Antenna Type	TRM R10	Trimble Integrated Antenna	

TOP OF MONUMENT IS:		X	FLUSH
METERS/FEET			ABOVE GROUND
METERS/FEET			BELOW GROUND

Parking Stripe Intersection

	AERIAL TARGET		PHOTO I.D.
	PUB. BENCH MARK	X	NEW CONTROL
	PUB. CONTROL		BASE STATION

PHOTO

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GPS CONTROL SURVEY
FIELD DATA SHEET

JOB REFERENCE	POINT ID:	ALN_03
Allentown, PA (USGS)	Proj. No.:	7494.0425

STATE	PA	COUNTY	LEHIGH	QUAD:	Allentown West (PA)

OPERATOR	ZJL

NAD83(2011) PA SPC SOUTH ZONE NAVD88 SURVEY FT.

Northing	468088.980	Elevation
Easting	2583295.070	323.830

RECEIVER MODEL	TRIMBLE R10
RECEIVER S/N	5413461432

SESSIONS		ObsA	Obs B
VRS	DATE:	04/26/16	05/03/16
	DAY OF YEAR	116	124

	Obs A	ObsB		
START TIME	11:20	09:14		U.T.C.
END TIME	11:23	09:15	X	LOCAL

ANTENNA HEIGHT (SLANT)				
MTRS/FT	2.000 Meters			
	MEASURED	X	FIXED HGT.	

ANTENNA HEIGHT (ARP)			
MTRS/FT	2.000 Meters		
	MEASURED	X	FIXED HGT

ANTENNA		
RADIUS (M)		
Antenna Serial #	5413461432	
Antenna Type	TRM R10	Trimble Integrated Antenna

TOP OF MONUMENT IS:		X	FLUSH
METERS/FEET			ABOVE GROUND
METERS/FEET			BELOW GROUND

Intersection of Parking Stripes

	AERIAL TARGET		PHOTO I.D.
	PUB. BENCH MARK	X	NEW CONTROL
	PUB. CONTROL		BASE STATION

PHOTO

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GPS CONTROL SURVEY
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JOB REFERENCE
Allentown, PA (USGS)

POINT ID:	ALN_04
Proj. No.:	7494.0425

STATE	PA	COUNTY	LEHIGH	QUAD:	Allentown West (PA)

OPERATOR	ZJL

NAD83(2011) PA SPC SOUTH ZONE NAVD88 SURVEY FT.

Northing	463313.250
Easting	2581080.340

Elevation
404.620

RECEIVER MODEL	TRIMBLE R10
RECEIVER S/N	5413461432

SESSIONS	DATE:	ObsA	Obs B
VRS	DAY OF YEAR	116	124

	Obs A	ObsB		
START TIME	08:15	08:50		U.T.C.
END TIME	08:18	08:50	X	LOCAL

ANTENNA HEIGHT (SLANT)				
MTRS/FT	2.000 Meters			
	MEASURED		X	FIXED HGT.

ANTENNA			
RADIUS (M)			
Antenna Serial #	5413461432		
Antenna Type	TRM R10	Trimble Integrated Antenna	

ANTENNA HEIGHT (ARP)				
MTRS/FT	2.000 Meters			
	MEASURED		X	FIXED HGT

TOP OF MONUMENT IS:		X	FLUSH
METERS/FEET			ABOVE GROUND
METERS/FEET			BELOW GROUND

Paint Stripe Intersection

	AERIAL TARGET		PHOTO I.D.
	PUB. BENCH MARK	X	NEW CONTROL
	PUB. CONTROL		BASE STATION

PHOTO

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JOB REFERENCE	POINT ID:	ALN_05
Allentown, PA (USGS)	Proj. No.:	7494.0425

STATE	PA	COUNTY	LEHIGH	QUAD:	Allentown West (PA)

OPERATOR	ZJL

RECEIVER MODEL	TRIMBLE R10
RECEIVER S/N	5413461432

NAD83(2011) PA SPC SOUTH ZONE NAVD88 SURVEY FT.

Northing	464165.740
Easting	2589166.450

Elevation
320.310

SESSIONS	DATE:	ObsA	Obs B
VRS	DAY OF YEAR	116	123

	Obs A	ObsB		
START TIME	08:47	11:42		U.T.C.
END TIME	08:50	11:43	X	LOCAL

ANTENNA HEIGHT (SLANT)				
MTRS/FT	2.000 Meters			
	MEASURED	X	FIXED HGT.	

ANTENNA HEIGHT (ARP)				
MTRS/FT	2.000 Meters			
	MEASURED	X	FIXED HGT	

ANTENNA			
RADIUS (M)			
Antenna Serial #	5413461432		
Antenna Type	TRM R10	Trimble Integrated Antenna	

TOP OF MONUMENT IS:		X	FLUSH
METERS/FEET			ABOVE GROUND
METERS/FEET			BELOW GROUND

Intersection of Paint Stripes

	AERIAL TARGET		PHOTO I.D.
	PUB. BENCH MARK	X	NEW CONTROL
	PUB. CONTROL		BASE STATION

PHOTO

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GPS CONTROL SURVEY
FIELD DATA SHEET

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JOB REFERENCE
Allentown, PA (USGS)

POINT ID:	ALN_06
Proj. No.:	7494.0425

STATE	PA	COUNTY	LEHIGH	QUAD:	Allentown West (PA)

OPERATOR	ZJL

NAD83(2011) PA SPC SOUTH ZONE NAVD88 SURVEY FT.

Northing	456030.810
Easting	2589813.370

Elevation
289.020

RECEIVER MODEL	TRIMBLE R10
RECEIVER S/N	5413461432

SESSIONS	DATE:	ObsA	Obs B
VRS	DAY OF YEAR	115	123

	Obs A	ObsB		
START TIME	09:54	09:09		U.T.C.
END TIME	09:57	09:10	X	LOCAL

ANTENNA HEIGHT (SLANT)				
MTRS/FT	2.000 Meters			
	MEASURED	X	FIXED HGT.	

ANTENNA HEIGHT (ARP)				
MTRS/FT	2.000 Meters			
	MEASURED	X	FIXED HGT	

ANTENNA			
RADIUS (M)			
Antenna Serial #	5413461432		
Antenna Type	TRM R10	Trimble Integrated Antenna	

TOP OF MONUMENT IS:		X	FLUSH
METERS/FEET			ABOVE GROUND
METERS/FEET			BELOW GROUND

Paint Arrow

	AERIAL TARGET		PHOTO I.D.
	PUB. BENCH MARK	X	NEW CONTROL
	PUB. CONTROL		BASE STATION

PHOTO

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GPS CONTROL SURVEY
FIELD DATA SHEET

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JOB REFERENCE
Allentown, PA (USGS)

POINT ID:	ALN_07
Proj. No.:	7494.0425

STATE	PA	COUNTY	LEHIGH	QUAD:	Allentown East (PA)

OPERATOR	ZJL

NAD83(2011) PA SPC SOUTH ZONE NAVD88 SURVEY FT.

Northing	452988.26
Easting	2600618.92

Elevation
491.73

RECEIVER MODEL	TRIMBLE R10
RECEIVER S/N	5413461432

SESSIONS	DATE:	ObsA	Obs B
VRS	DAY OF YEAR	115	123

	Obs A	ObsB		
START TIME	10:29	09:43		U.T.C.
END TIME	10:32	09:44	X	LOCAL

ANTENNA HEIGHT (SLANT)				
MTRS/FT	2.000 Meters			
	MEASURED	X	FIXED HGT.	

ANTENNA			
RADIUS (M)			
Antenna Serial #	5413461432		
Antenna Type	TRM R10	Trimble Integrated Antenna	

ANTENNA HEIGHT (ARP)			
MTRS/FT	2.000 Meters		
	MEASURED	X	FIXED HGT

TOP OF MONUMENT IS:		X	FLUSH
METERS/FEET			ABOVE GROUND
METERS/FEET			BELOW GROUND

Intersection of Paint Stripes

	AERIAL TARGET		PHOTO I.D.
	PUB. BENCH MARK	X	NEW CONTROL
	PUB. CONTROL		BASE STATION

PHOTO

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GPS CONTROL SURVEY
FIELD DATA SHEET

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JOB REFERENCE
Allentown, PA (USGS)

POINT ID:	ALN_08
Proj. No.:	7494.0425

STATE	PA	COUNTY	LEHIGH	QUAD:	Allentown East (PA)

OPERATOR	ZJL

NAD83(2011) PA SPC SOUTH ZONE NAVD88 SURVEY FT.

Northing	457224.94
Easting	2596701.24

Elevation
400.360

RECEIVER MODEL	TRIMBLE R10
RECEIVER S/N	5413461432

SESSIONS	DATE:	ObsA	Obs B
VRS	DAY OF YEAR	115	123

	Obs A	ObsB		
START TIME	10:58	10:10		U.T.C.
END TIME	11:01	10:11	X	LOCAL

ANTENNA HEIGHT (SLANT)				
MTRS/FT	2.000 Meters			
	MEASURED	X	FIXED HGT.	

ANTENNA HEIGHT (ARP)			
MTRS/FT	2.000 Meters		
	MEASURED	X	FIXED HGT

ANTENNA			
RADIUS (M)			
Antenna Serial #	5413461432		
Antenna Type	TRM R10	Trimble Integrated Antenna	

TOP OF MONUMENT IS:		X	FLUSH
METERS/FEET			ABOVE GROUND
METERS/FEET			BELOW GROUND

Tip fo Paint Arrow

	AERIAL TARGET		PHOTO I.D.
	PUB. BENCH MARK	X	NEW CONTROL
	PUB. CONTROL		BASE STATION

PHOTO

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GPS CONTROL SURVEY
FIELD DATA SHEET

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JOB REFERENCE
Allentown, PA (USGS)

POINT ID:	ALN_09
Proj. No.:	7494.0425

STATE	PA	COUNTY	LEHIGH	QUAD:	Allentown East (PA)

OPERATOR	ZJL

NAD83(2011) PA SPC SOUTH ZONE NAVD88 SURVEY FT.

Northing	457082.89
Easting	2607448.43

Elevation
707.80

RECEIVER MODEL	TRIMBLE R10
RECEIVER S/N	5413461432

SESSIONS	DATE:	ObsA	Obs B
VRS	DAY OF YEAR	115	123

	Obs A	ObsB		
START TIME	12:33	10:22		U.T.C.
END TIME	12:36	10:23	X	LOCAL

ANTENNA HEIGHT (SLANT)				
MTRS/FT	2.000 Meters			
	MEASURED	X	FIXED HGT.	

ANTENNA HEIGHT (ARP)				
MTRS/FT	2.000 Meters			
	MEASURED	X	FIXED HGT	

ANTENNA			
RADIUS (M)			
Antenna Serial #	5413461432		
Antenna Type	TRM R10	Trimble Integrated Antenna	

TOP OF MONUMENT IS:		X	FLUSH
METERS/FEET			ABOVE GROUND
METERS/FEET			BELOW GROUND

Tip of Paint Arrow

	AERIAL TARGET		PHOTO I.D.
	PUB. BENCH MARK	X	NEW CONTROL
	PUB. CONTROL		BASE STATION

PHOTO

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FIELD DATA SHEET

JOB REFERENCE	POINT ID:	ALN_10
Allentown, PA (USGS)	Proj. No.:	7494.0425

STATE	PA	COUNTY	LEHIGH	QUAD:	Allentown East (PA)

OPERATOR	ZJL

NAD83(2011) PA SPC SOUTH ZONE NAVD88 SURVEY FT.

Northing	464012.51
Easting	2604625.84

Elevation
350.54

RECEIVER MODEL	TRIMBLE R10
RECEIVER S/N	5413461432

SESSIONS	DATE:	ObsA	Obs B
VRS	DAY OF YEAR	115	123

	Obs A	ObsB		
START TIME	13:09	10:37		U.T.C.
END TIME	13:12	10:38	X	LOCAL

ANTENNA HEIGHT (SLANT)				
MTRS/FT	2.000 Meters			
	MEASURED	X	FIXED HGT.	

ANTENNA HEIGHT (ARP)				
MTRS/FT	2.000 Meters			
	MEASURED	X	FIXED HGT	

ANTENNA			
RADIUS (M)			
Antenna Serial #	5413461432		
Antenna Type	TRM R10	Trimble Integrated Antenna	

TOP OF MONUMENT IS:		X	FLUSH
METERS/FEET			ABOVE GROUND
METERS/FEET			BELOW GROUND

Corner of Stop Bar

	AERIAL TARGET		PHOTO I.D.
	PUB. BENCH MARK	X	NEW CONTROL
	PUB. CONTROL		BASE STATION

PHOTO

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FIELD DATA SHEET

JOB REFERENCE	POINT ID:	ALN_11
Allentown, PA (USGS)	Proj. No.:	7494.0425

STATE	PA	COUNTY	LEHIGH	QUAD:	Allentown East (PA)

OPERATOR	ZJL

NAD83(2011) PA SPC SOUTH ZONE NAVD88 SURVEY FT.

Northing	466166.89	Elevation
Easting	2612946.09	513.47

RECEIVER MODEL	TRIMBLE R10
RECEIVER S/N	5413461432

SESSIONS	DATE:	ObsA	Obs B
VRS	DAY OF YEAR	115	123

	Obs A	ObsB		
START TIME	13:46	11:02		U.T.C.
END TIME	13:49	11:03	X	LOCAL

ANTENNA HEIGHT (SLANT)				
MTRS/FT	2.000 Meters			
	MEASURED	X	FIXED HGT.	

ANTENNA HEIGHT (ARP)				
MTRS/FT	2.000 Meters			
	MEASURED	X	FIXED HGT	

ANTENNA			
RADIUS (M)			
Antenna Serial #	5413461432		
Antenna Type	TRM R10	Trimble Integrated Antenna	

TOP OF MONUMENT IS:		X	FLUSH
METERS/FEET			ABOVE GROUND
METERS/FEET			BELOW GROUND

Corner of Metal Lid

	AERIAL TARGET		PHOTO I.D.
	PUB. BENCH MARK	X	NEW CONTROL
	PUB. CONTROL		BASE STATION

PHOTO

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GPS CONTROL SURVEY
FIELD DATA SHEET

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JOB REFERENCE
Allentown, PA (USGS)

POINT ID:	ALN_12
Proj. No.:	7494.0425

STATE	PA	COUNTY	LEHIGH	QUAD:	Allentown East (PA)

OPERATOR	ZJL

NAD83(2011) PA SPC SOUTH ZONE NAVD88 SURVEY FT.

Northing	472369.33
Easting	2598221.07

Elevation
355.72

RECEIVER MODEL	TRIMBLE R10
RECEIVER S/N	5413461432

SESSIONS	DATE:	ObsA	Obs B
VRS	DAY OF YEAR	117	123

	Obs A	ObsB		
START TIME	09:13	12:50		U.T.C.
END TIME	09:16	12:50	X	LOCAL

ANTENNA HEIGHT (SLANT)				
MTRS/FT	2.000 Meters			
	MEASURED	X	FIXED HGT.	

ANTENNA HEIGHT (ARP)				
MTRS/FT	2.000 Meters			
	MEASURED	X	FIXED HGT	

ANTENNA			
RADIUS (M)			
Antenna Serial #	5413461432		
Antenna Type	TRM R10	Trimble Integrated Antenna	

TOP OF MONUMENT IS:		X	FLUSH
METERS/FEET			ABOVE GROUND
METERS/FEET			BELOW GROUND

Intersection of Parking Stripes

	AERIAL TARGET		PHOTO I.D.
	PUB. BENCH MARK	X	NEW CONTROL
	PUB. CONTROL		BASE STATION

PHOTO

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GPS CONTROL SURVEY
FIELD DATA SHEET

JOB REFERENCE	POINT ID:	ALN_13
Allentown, PA (USGS)	Proj. No.:	7494.0425

STATE	PA	COUNTY	LEHIGH	QUAD:	Allentown West (PA)

OPERATOR	ZJL

NAD83(2011) PA SPC SOUTH ZONE NAVD88 SURVEY FT.

Northing	477074.67	Elevation
Easting	2591950.49	393.14

RECEIVER MODEL	TRIMBLE R10
RECEIVER S/N	5413461432

SESSIONS	DATE:	ObsA	Obs B
VRS	DAY OF YEAR	116	123

	Obs A	ObsB		
START TIME	13:35	14:02		U.T.C.
END TIME	13:38	14:03	X	LOCAL

ANTENNA HEIGHT (SLANT)				
MTRS/FT	2.000 Meters			
	MEASURED	X	FIXED HGT.	

ANTENNA HEIGHT (ARP)				
MTRS/FT	2.000 Meters			
	MEASURED	X	FIXED HGT	

ANTENNA			
RADIUS (M)			
Antenna Serial #	5413461432		
Antenna Type	TRM R10	Trimble Integrated Antenna	

TOP OF MONUMENT IS:		X	FLUSH
METERS/FEET			ABOVE GROUND
METERS/FEET			BELOW GROUND

Tip of Paint Arrow

	AERIAL TARGET		PHOTO I.D.
	PUB. BENCH MARK	X	NEW CONTROL
	PUB. CONTROL		BASE STATION

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FIELD DATA SHEET

JOB REFERENCE	POINT ID:	ALN_14
Allentown, PA (USGS)	Proj. No.:	7494.0425

STATE	PA	COUNTY	LEHIGH	QUAD:	Catasauqua (PA)

OPERATOR	ZJL

NAD83(2011) PA SPC SOUTH ZONE NAVD88 SURVEY FT.

Northing	481083.82	Elevation
Easting	2601305.00	350.34

RECEIVER MODEL	TRIMBLE R10
RECEIVER S/N	5413461432

SESSIONS	DATE:	ObsA	Obs B
VRS	DAY OF YEAR	117	123

	Obs A	ObsB		
START TIME	10:22	14:14		U.T.C.
END TIME	10:25	14:14	X	LOCAL

ANTENNA HEIGHT (SLANT)				
MTRS/FT	2.000 Meters			
	MEASURED	X	FIXED HGT.	

ANTENNA HEIGHT (ARP)				
MTRS/FT	2.000 Meters			
	MEASURED	X	FIXED HGT	

ANTENNA			
RADIUS (M)			
Antenna Serial #	5413461432		
Antenna Type	TRM R10	Trimble Integrated Antenna	

TOP OF MONUMENT IS:		X	FLUSH
METERS/FEET			ABOVE GROUND
METERS/FEET			BELOW GROUND

Intersection of Paint Stripes

	AERIAL TARGET		PHOTO I.D.
	PUB. BENCH MARK	X	NEW CONTROL
	PUB. CONTROL		BASE STATION

PHOTO

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JOB REFERENCE
Allentown, PA (USGS)

POINT ID:	ALN_15
Proj. No.:	7494.0425

STATE	PA	COUNTY	LEHIGH	QUAD:	Allentown East (PA)

OPERATOR	ZJL

NAD83(2011) PA SPC SOUTH ZONE NAVD88 SURVEY FT.

Northing	476307.26
Easting	2610917.81

Elevation
358.68

RECEIVER MODEL	TRIMBLE R10
RECEIVER S/N	5413461432

SESSIONS	DATE:	ObsA	Obs B
VRS	DAY OF YEAR	117	124

	Obs A	ObsB		
START TIME	13:15	11:41		U.T.C.
END TIME	13:18	11:42	X	LOCAL

ANTENNA HEIGHT (SLANT)				
MTRS/FT	2.000 Meters			
	MEASURED	X	FIXED HGT.	

ANTENNA HEIGHT (ARP)			
MTRS/FT	2.000 Meters		
	MEASURED	X	FIXED HGT

ANTENNA			
RADIUS (M)			
Antenna Serial #	5413461432		
Antenna Type	TRM R10	Trimble Integrated Antenna	

TOP OF MONUMENT IS:		X	FLUSH
METERS/FEET			ABOVE GROUND
METERS/FEET			BELOW GROUND

Tip of Paint Triangle

	AERIAL TARGET		PHOTO I.D.
	PUB. BENCH MARK	X	NEW CONTROL
	PUB. CONTROL		BASE STATION

PHOTO

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GPS CONTROL SURVEY
FIELD DATA SHEET

JOB REFERENCE	POINT ID:	ALN_16
Allentown, PA (USGS)	Proj. No.:	7494.0425

STATE	PA	COUNTY	LEHIGH	QUAD:	Catasauqua (PA)

OPERATOR	ZJL

NAD83(2011) PA SPC SOUTH ZONE NAVD88 SURVEY FT.

Northing	484307.75	Elevation
Easting	2610807.88	362.68

RECEIVER MODEL	TRIMBLE R10
RECEIVER S/N	5413461432

SESSIONS	DATE:	ObsA	Obs B
VRS	DAY OF YEAR	117	123

	Obs A	ObsB		
START TIME	11:09	14:29		U.T.C.
END TIME	11:12	14:29	X	LOCAL

ANTENNA HEIGHT (SLANT)				
MTRS/FT	2.000 Meters			
	MEASURED	X	FIXED HGT.	

ANTENNA HEIGHT (ARP)			
MTRS/FT	2.000 Meters		
	MEASURED	X	FIXED HGT

ANTENNA			
RADIUS (M)			
Antenna Serial #	5413461432		
Antenna Type	TRM R10	Trimble Integrated Antenna	

TOP OF MONUMENT IS:		X	FLUSH
METERS/FEET			ABOVE GROUND
METERS/FEET			BELOW GROUND

Corner of Stop Bar

	AERIAL TARGET		PHOTO I.D.
	PUB. BENCH MARK	X	NEW CONTROL
	PUB. CONTROL		BASE STATION

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GPS CONTROL SURVEY
FIELD DATA SHEET

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JOB REFERENCE
Allentown, PA (USGS)

POINT ID:	ALN_17
Proj. No.:	7494.0425

STATE	PA	COUNTY	LEHIGH	QUAD:	Allentown East (PA)

OPERATOR	ZJL

NAD83(2011) PA SPC SOUTH ZONE NAVD88 SURVEY FT.

Northing	477264.32
Easting	2618593.99

Elevation
299.86

RECEIVER MODEL	TRIMBLE R10
RECEIVER S/N	5413461432

SESSIONS	DATE:	ObsA	Obs B
VRS	DAY OF YEAR	117	124

	Obs A	ObsB		
START TIME	12:38	11:08		U.T.C.
END TIME	12:41	11:09	X	LOCAL

ANTENNA HEIGHT (SLANT)				
MTRS/FT	2.000 Meters			
	MEASURED	X	FIXED HGT.	

ANTENNA HEIGHT (ARP)				
MTRS/FT	2.000 Meters			
	MEASURED	X	FIXED HGT	

ANTENNA			
RADIUS (M)			
Antenna Serial #	5413461432		
Antenna Type	TRM R10	Trimble Integrated Antenna	

TOP OF MONUMENT IS:		X	FLUSH
METERS/FEET			ABOVE GROUND
METERS/FEET			BELOW GROUND

Paint Stripe Intersection

	AERIAL TARGET		PHOTO I.D.
	PUB. BENCH MARK	X	NEW CONTROL
	PUB. CONTROL		BASE STATION

PHOTO

PHOTO:

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GPS CONTROL SURVEY
FIELD DATA SHEET

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JOB REFERENCE
Allentown, PA (USGS)

POINT ID:	ALN_18
Proj. No.:	7494.0425

STATE	PA	COUNTY	LEHIGH	QUAD:	Catasauqua (PA)

OPERATOR	ZJL

NAD83(2011) PA SPC SOUTH ZONE NAVD88 SURVEY FT.

Northing	482806.55
Easting	2614775.81

Elevation
349.90

RECEIVER MODEL	TRIMBLE R10
RECEIVER S/N	5413461432

SESSIONS	DATE:	ObsA	Obs B
VRS	DAY OF YEAR	117	123

	Obs A	ObsB		
START TIME	12:18	14:42		U.T.C.
END TIME	12:22	14:43	X	LOCAL

ANTENNA HEIGHT (SLANT)				
MTRS/FT	2.000 Meters			
	MEASURED	X	FIXED HGT.	

ANTENNA HEIGHT (ARP)				
MTRS/FT	2.000 Meters			
	MEASURED	X	FIXED HGT	

ANTENNA			
RADIUS (M)			
Antenna Serial #	5413461432		
Antenna Type	TRM R10	Trimble Integrated Antenna	

TOP OF MONUMENT IS:		X	FLUSH
METERS/FEET			ABOVE GROUND
METERS/FEET			BELOW GROUND

Intersection of Paint Stripes

	AERIAL TARGET		PHOTO I.D.
	PUB. BENCH MARK	X	NEW CONTROL
	PUB. CONTROL		BASE STATION

PHOTO

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GPS CONTROL SURVEY
FIELD DATA SHEET

JOB REFERENCE	POINT ID:	BE_01
Allentown, PA (USGS)	Proj. No.:	7494.0425

STATE	PA	COUNTY	LEHIGH	QUAD:	Allentown West (PA)

OPERATOR	ZJL

NAD83(2011) PA SPC SOUTH ZONE NAVD88 SURVEY FT.

Northing	463505.75	Elevation
Easting	2588159.14	329.96

RECEIVER MODEL	TRIMBLE R10
RECEIVER S/N	5413461432

SESSIONS	DATE:	ObsA	Obs B
VRS	DAY OF YEAR	116	123

	Obs A	ObsB		
START TIME	08:35	11:49		U.T.C.
END TIME	08:38	11:50	X	LOCAL

ANTENNA HEIGHT (SLANT)				
MTRS/FT	2.000 Meters			
	MEASURED	X	FIXED HGT.	

ANTENNA HEIGHT (ARP)			
MTRS/FT	2.000 Meters		
	MEASURED	X	FIXED HGT

ANTENNA			
RADIUS (M)			
Antenna Serial #	5413461432		
Antenna Type	TRM R10	Trimble Integrated Antenna	

TOP OF MONUMENT IS:		X	FLUSH
METERS/FEET			ABOVE GROUND
METERS/FEET			BELOW GROUND

Dirt Infield

	AERIAL TARGET		PHOTO I.D.
	PUB. BENCH MARK	X	NEW CONTROL
	PUB. CONTROL		BASE STATION

PHOTO

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GPS CONTROL SURVEY
FIELD DATA SHEET

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JOB REFERENCE
Allentown, PA (USGS)

POINT ID:	BE_02
Proj. No.:	7494.0425

STATE	PA	COUNTY	LEHIGH	QUAD:	Allentown East (PA)

OPERATOR	ZJL

NAD83(2011) PA SPC SOUTH ZONE NAVD88 SURVEY FT.

Northing	456416.75
Easting	2594774.56

Elevation
376.62

RECEIVER MODEL	TRIMBLE R10
RECEIVER S/N	5413461432

SESSIONS	DATE:	ObsA	Obs B
VRS	DAY OF YEAR	115	123

	Obs A	ObsB		
START TIME	10:09	09:19		U.T.C.
END TIME	10:12	09:20	X	LOCAL

ANTENNA HEIGHT (SLANT)				
MTRS/FT	2.000 Meters			
	MEASURED	X	FIXED HGT.	

ANTENNA HEIGHT (ARP)			
MTRS/FT	2.000 Meters		
	MEASURED	X	FIXED HGT

ANTENNA			
RADIUS (M)			
Antenna Serial #	5413461432		
Antenna Type	TRM R10	Trimble Integrated Antenna	

TOP OF MONUMENT IS:	X	FLUSH
METERS/FEET		ABOVE GROUND
METERS/FEET		BELOW GROUND

Dirt Infield

	AERIAL TARGET		PHOTO I.D.
	PUB. BENCH MARK	X	NEW CONTROL
	PUB. CONTROL		BASE STATION

PHOTO

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GPS CONTROL SURVEY
FIELD DATA SHEET

JOB REFERENCE	POINT ID:	BE_03
Allentown, PA (USGS)	Proj. No.:	7494.0425

STATE	PA	COUNTY	LEHIGH	QUAD:	Allentown East (PA)

OPERATOR	ZJL

NAD83(2011) PA SPC SOUTH ZONE NAVD88 SURVEY FT.

Northing	470848.50	Elevation
Easting	2608849.11	341.49

RECEIVER MODEL	TRIMBLE R10
RECEIVER S/N	5413461432

SESSIONS	DATE:	ObsA	Obs B
VRS	DAY OF YEAR	117	124

	Obs A	ObsB		
START TIME	13:00	11:28		U.T.C.
END TIME	13:03	11:29	X	LOCAL

ANTENNA HEIGHT (SLANT)				
MTRS/FT	2.000 Meters			
	MEASURED	X	FIXED HGT.	

ANTENNA HEIGHT (ARP)			
MTRS/FT	2.000 Meters		
	MEASURED	X	FIXED HGT

ANTENNA			
RADIUS (M)			
Antenna Serial #	5413461432		
Antenna Type	TRM R10	Trimble Integrated Antenna	

TOP OF MONUMENT IS:		X	FLUSH
METERS/FEET			ABOVE GROUND
METERS/FEET			BELOW GROUND

Dirt Infield

	AERIAL TARGET		PHOTO I.D.
	PUB. BENCH MARK	X	NEW CONTROL
	PUB. CONTROL		BASE STATION

PHOTO

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GPS CONTROL SURVEY
FIELD DATA SHEET

JOB REFERENCE	POINT ID:	BE_04
Allentown, PA (USGS)	Proj. No.:	7494.0425

STATE	PA	COUNTY	LEHIGH	QUAD:	Allentown East (PA)

OPERATOR	ZJL

NAD83(2011) PA SPC SOUTH ZONE NAVD88 SURVEY FT.

Northing	477516.38	Elevation
Easting	2598983.57	263.41

RECEIVER MODEL	TRIMBLE R10
RECEIVER S/N	5413461432

SESSIONS	DATE:	ObsA	Obs B
VRS	DAY OF YEAR	117	123

	Obs A	ObsB		
START TIME	09:50	13:38		U.T.C.
END TIME	09:53	13:39	X	LOCAL

ANTENNA HEIGHT (SLANT)				
MTRS/FT	2.000 Meters			
	MEASURED	X	FIXED HGT.	

ANTENNA HEIGHT (ARP)			
MTRS/FT	2.000 Meters		
	MEASURED	X	FIXED HGT

ANTENNA			
RADIUS (M)			
Antenna Serial #	5413461432		
Antenna Type	TRM R10	Trimble Integrated Antenna	

TOP OF MONUMENT IS:		X	FLUSH
METERS/FEET			ABOVE GROUND
METERS/FEET			BELOW GROUND

Dirt Infield

	AERIAL TARGET		PHOTO I.D.
	PUB. BENCH MARK	X	NEW CONTROL
	PUB. CONTROL		BASE STATION

PHOTO

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GPS CONTROL SURVEY
FIELD DATA SHEET

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JOB REFERENCE
Allentown, PA (USGS)

POINT ID:	FO_01
Proj. No.:	7494.0425

STATE	PA	COUNTY	LEHIGH	QUAD:	Allentown West (PA)

OPERATOR	ZJL

NAD83(2011) PA SPC SOUTH ZONE NAVD88 SURVEY FT.

Northing	453627.28
Easting	2592314.88

Elevation
385.72

RECEIVER MODEL	TRIMBLE R10
RECEIVER S/N	5413461432

SESSIONS	DATE:	ObsA	Obs B
VRS	DAY OF YEAR	115	123

	Obs A	ObsB		
START TIME	9:13/9:27	8:56/9:01		U.T.C.
END TIME	9:16/9:30	8:56/9:02	X	LOCAL

ANTENNA HEIGHT (SLANT)				
MTRS/FT	2.000 Meters			
	MEASURED	X	FIXED HGT.	

ANTENNA		
RADIUS (M)		
Antenna Serial #	5413461432	
Antenna Type	TRM R10	Trimble Integrated Antenna

ANTENNA HEIGHT (ARP)			
MTRS/FT	2.000 Meters		
	MEASURED	X	FIXED HGT

TOP OF MONUMENT IS:		X	FLUSH
METERS/FEET			ABOVE GROUND
METERS/FEET			BELOW GROUND

Trimble S8 Robotic Total Station
Insrtument @ C-100, Backsight UA_15
Instrument Height 5.48 Backsight Height 5.20
Backsight Check H=.026 V=.013
Woods

	AERIAL TARGET		PHOTO I.D.
	PUB. BENCH MARK	X	NEW CONTROL
	PUB. CONTROL		BASE STATION

PHOTO:

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GPS CONTROL SURVEY
FIELD DATA SHEET

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JOB REFERENCE
Allentown, PA (USGS)

POINT ID:	FO_02
Proj. No.:	7494.0425

STATE	PA	COUNTY	LEHIGH	QUAD:	Allentown West (PA)

OPERATOR	ZJL

NAD83(2011) PA SPC SOUTH ZONE NAVD88 SURVEY FT.

Northing	465699.64
Easting	2585245.67

Elevation
322.77

RECEIVER MODEL	TRIMBLE R10
RECEIVER S/N	5413461432

SESSIONS	DATE:	ObsA	Obs B
VRS	DAY OF YEAR	116	124

	Obs A	ObsB		
START TIME	10:42/10:55	9:04/9:01		U.T.C.
END TIME	10:45/10:55	9:05/9:02	X	LOCAL

ANTENNA HEIGHT (SLANT)				
MTRS/FT	2.000 Meters			
	MEASURED	X	FIXED HGT.	

ANTENNA			
RADIUS (M)			
Antenna Serial #	5413461432		
Antenna Type	TRM R10	Trimble Integrated Antenna	

ANTENNA HEIGHT (ARP)			
MTRS/FT	2.000 Meters		
	MEASURED	X	FIXED HGT

TOP OF MONUMENT IS:		X	FLUSH
METERS/FEET			ABOVE GROUND
METERS/FEET			BELOW GROUND

Trimble S8 Robotic Total Station
Insrtument @ C-101, Backsight C_102
Instrument Height 5.72 Backsight Height 5.20
Backsight Check H=.006 V=.004
Woods

	AERIAL TARGET		PHOTO I.D.
	PUB. BENCH MARK	X	NEW CONTROL
	PUB. CONTROL		BASE STATION

PHOTO

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GPS CONTROL SURVEY
FIELD DATA SHEET

JOB REFERENCE	POINT ID:	ORT_01
Allentown, PA (USGS)	Proj. No.:	7494.0425

STATE	PA	COUNTY	LEHIGH	QUAD:	Allentown East (PA)

OPERATOR	ZJL

NAD83(2011) PA SPC SOUTH ZONE NAVD88 SURVEY FT.

Northing	453833.28	Elevation
Easting	2599942.61	429.34

RECEIVER MODEL	TRIMBLE R10
RECEIVER S/N	5413461432

SESSIONS	DATE:	ObsA	Obs B
VRS	DAY OF YEAR	115	123

	Obs A	ObsB		
START TIME	10:41	09:36		U.T.C.
END TIME	10:44	09:37	X	LOCAL

ANTENNA HEIGHT (SLANT)				
MTRS/FT	2.000 Meters			
	MEASURED	X	FIXED HGT.	

ANTENNA HEIGHT (ARP)			
MTRS/FT	2.000 Meters		
	MEASURED	X	FIXED HGT

ANTENNA			
RADIUS (M)			
Antenna Serial #	5413461432		
Antenna Type	TRM R10	Trimble Integrated Antenna	

TOP OF MONUMENT IS:		X	FLUSH
METERS/FEET			ABOVE GROUND
METERS/FEET			BELOW GROUND

Intersection of Pain Stripes

	AERIAL TARGET		PHOTO I.D.
	PUB. BENCH MARK	X	NEW CONTROL
	PUB. CONTROL		BASE STATION

PHOTO

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GPS CONTROL SURVEY
FIELD DATA SHEET

JOB REFERENCE	POINT ID:	ORT_02
Allentown, PA (USGS)	Proj. No.:	7494.0425

STATE	PA	COUNTY	LEHIGH	QUAD:	Allentown West (PA)

OPERATOR	ZJL

NAD83(2011) PA SPC SOUTH ZONE NAVD88 SURVEY FT.

Northing	463939.70	Elevation
Easting	2590119.11	348.62

RECEIVER MODEL	TRIMBLE R10
RECEIVER S/N	5413461432

SESSIONS	DATE:	ObsA	Obs B
VRS	DAY OF YEAR	116	123

	Obs A	ObsB		
START TIME	08:56	11:34		U.T.C.
END TIME	08:59	11:34	X	LOCAL

ANTENNA HEIGHT (SLANT)				
MTRS/FT	2.000 Meters			
	MEASURED	X	FIXED HGT.	

ANTENNA HEIGHT (ARP)			
MTRS/FT	2.000 Meters		
	MEASURED	X	FIXED HGT

ANTENNA			
RADIUS (M)			
Antenna Serial #	5413461432		
Antenna Type	TRM R10	Trimble Integrated Antenna	

TOP OF MONUMENT IS:		X	FLUSH
METERS/FEET			ABOVE GROUND
METERS/FEET			BELOW GROUND

Sidewalk Corner

	AERIAL TARGET		PHOTO I.D.
	PUB. BENCH MARK	X	NEW CONTROL
	PUB. CONTROL		BASE STATION

PHOTO

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GPS CONTROL SURVEY
FIELD DATA SHEET

JOB REFERENCE	POINT ID:	ORT_03
Allentown, PA (USGS)	Proj. No.:	7494.0425

STATE	PA	COUNTY	LEHIGH	QUAD:	Catasauqua (PA)

OPERATOR	ZJL

NAD83(2011) PA SPC SOUTH ZONE NAVD88 SURVEY FT.

Northing	479964.78	Elevation
Easting	2609238.22	339.76

RECEIVER MODEL	TRIMBLE R10
RECEIVER S/N	5413461432

SESSIONS	DATE:	ObsA	Obs B
VRS	DAY OF YEAR	117	123

	Obs A	ObsB		
START TIME	11:20	14:57		U.T.C.
END TIME	11:23	14:58	X	LOCAL

ANTENNA HEIGHT (SLANT)				
MTRS/FT	2.000 Meters			
	MEASURED	X	FIXED HGT.	

ANTENNA HEIGHT (ARP)			
MTRS/FT	2.000 Meters		
	MEASURED	X	FIXED HGT

ANTENNA			
RADIUS (M)			
Antenna Serial #	5413461432		
Antenna Type	TRM R10	Trimble Integrated Antenna	

TOP OF MONUMENT IS:		X	FLUSH
METERS/FEET			ABOVE GROUND
METERS/FEET			BELOW GROUND

Tip of Paint Arrow

	AERIAL TARGET		PHOTO I.D.
	PUB. BENCH MARK	X	NEW CONTROL
	PUB. CONTROL		BASE STATION

PHOTO

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GPS CONTROL SURVEY
FIELD DATA SHEET

JOB REFERENCE	POINT ID:	ORT_04
Allentown, PA (USGS)	Proj. No.:	7494.0425

STATE	PA	COUNTY	LEHIGH	QUAD:	Allentown East (PA)

OPERATOR	ZJL

NAD83(2011) PA SPC SOUTH ZONE NAVD88 SURVEY FT.

Northing	475560.33	Elevation
Easting	2593730.94	392.18

RECEIVER MODEL	TRIMBLE R10
RECEIVER S/N	5413461432

SESSIONS	DATE:	ObsA	Obs B
VRS	DAY OF YEAR	116	123

	Obs A	ObsB		
START TIME	13:48	13:53		U.T.C.
END TIME	13:51	13:54	X	LOCAL

ANTENNA HEIGHT (SLANT)				
MTRS/FT	2.000 Meters			
	MEASURED	X	FIXED HGT.	

ANTENNA			
RADIUS (M)			
Antenna Serial #	5413461432		
Antenna Type	TRM R10	Trimble Integrated Antenna	

ANTENNA HEIGHT (ARP)			
MTRS/FT	2.000 Meters		
	MEASURED	X	FIXED HGT

TOP OF MONUMENT IS:		X	FLUSH
METERS/FEET			ABOVE GROUND
METERS/FEET			BELOW GROUND

Corner of Sidewalk

	AERIAL TARGET		PHOTO I.D.
	PUB. BENCH MARK	X	NEW CONTROL
	PUB. CONTROL		BASE STATION

PHOTO

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GPS CONTROL SURVEY
FIELD DATA SHEET

JOB REFERENCE	POINT ID:	SH_01
Allentown, PA (USGS)	Proj. No.:	7494.0425

STATE	PA	COUNTY	LEHIGH	QUAD:	Catasauqua (PA)

OPERATOR	ZJL

NAD83(2011) PA SPC SOUTH ZONE NAVD88 SURVEY FT.

Northing	480182.37	Elevation
Easting	2606862.22	344.88

RECEIVER MODEL	TRIMBLE R10
RECEIVER S/N	5413461432

SESSIONS	DATE:	ObsA	Obs B
VRS	DAY OF YEAR	117	124

	Obs A	ObsB		
START TIME	11:44	10:30		U.T.C.
END TIME	11:47	10:31	X	LOCAL

ANTENNA HEIGHT (SLANT)				
MTRS/FT	2.000 Meters			
	MEASURED	X	FIXED HGT.	

ANTENNA HEIGHT (ARP)			
MTRS/FT	2.000 Meters		
	MEASURED	X	FIXED HGT

ANTENNA			
RADIUS (M)			
Antenna Serial #	5413461432		
Antenna Type	TRM R10	Trimble Integrated Antenna	

TOP OF MONUMENT IS:		X	FLUSH
METERS/FEET			ABOVE GROUND
METERS/FEET			BELOW GROUND

Shrubs

	AERIAL TARGET		PHOTO I.D.
	PUB. BENCH MARK	X	NEW CONTROL
	PUB. CONTROL		BASE STATION

PHOTO

PHOTO:

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GPS CONTROL SURVEY
FIELD DATA SHEET

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JOB REFERENCE
Allentown, PA (USGS)

POINT ID:	TW_01
Proj. No.:	7494.0425

STATE	PA	COUNTY	LEHIGH	QUAD:	Allentown East (PA)

OPERATOR	ZJL

NAD83(2011) PA SPC SOUTH ZONE NAVD88 SURVEY FT.

Northing	457923.01
Easting	2599800.66

Elevation
382.75

RECEIVER MODEL	TRIMBLE R10
RECEIVER S/N	5413461432

SESSIONS	DATE:	ObsA	Obs B
VRS	DAY OF YEAR	115	123

	Obs A	ObsB		
START TIME	12:13	09:59		U.T.C.
END TIME	12:16	10:00	X	LOCAL

ANTENNA HEIGHT (SLANT)				
MTRS/FT	2.000 Meters			
	MEASURED	X	FIXED HGT.	

ANTENNA HEIGHT (ARP)			
MTRS/FT	2.000 Meters		
	MEASURED	X	FIXED HGT

ANTENNA			
RADIUS (M)			
Antenna Serial #	5413461432		
Antenna Type	TRM R10	Trimble Integrated Antenna	

TOP OF MONUMENT IS:		X	FLUSH
METERS/FEET			ABOVE GROUND
METERS/FEET			BELOW GROUND

Tall Grass/Weeds

	AERIAL TARGET		PHOTO I.D.
	PUB. BENCH MARK	X	NEW CONTROL
	PUB. CONTROL		BASE STATION

PHOTO

PHOTO:

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GPS CONTROL SURVEY
FIELD DATA SHEET

JOB REFERENCE	POINT ID:	TW_02
Allentown, PA (USGS)	Proj. No.:	7494.0425

STATE	PA	COUNTY	LEHIGH	QUAD:	Allentown East (PA)

OPERATOR	ZJL

NAD83(2011) PA SPC SOUTH ZONE NAVD88 SURVEY FT.

Northing	475831.58	Elevation
Easting	2614432.47	245.51

RECEIVER MODEL	TRIMBLE R10
RECEIVER S/N	5413461432

SESSIONS	DATE:	ObsA	Obs B
VRS	DAY OF YEAR	117	124

	Obs A	ObsB		
START TIME	12:48	11:18		U.T.C.
END TIME	12:51	11:19	X	LOCAL

ANTENNA HEIGHT (SLANT)				
MTRS/FT	2.000 Meters			
	MEASURED	X	FIXED HGT.	

ANTENNA HEIGHT (ARP)			
MTRS/FT	2.000 Meters		
	MEASURED	X	FIXED HGT

ANTENNA		
RADIUS (M)		
Antenna Serial #	5413461432	
Antenna Type	TRM R10	Trimble Integrated Antenna

TOP OF MONUMENT IS:		X	FLUSH
METERS/FEET			ABOVE GROUND
METERS/FEET			BELOW GROUND

Tall Weeds

	AERIAL TARGET		PHOTO I.D.
	PUB. BENCH MARK	X	NEW CONTROL
	PUB. CONTROL		BASE STATION

PHOTO

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GPS CONTROL SURVEY
FIELD DATA SHEET

JOB REFERENCE	POINT ID:	UA_01
Allentown, PA (USGS)	Proj. No.:	7494.0425

STATE	PA	COUNTY	LEHIGH	QUAD:	Allentown West (PA)

OPERATOR	ZJL

NAD83(2011) PA SPC SOUTH ZONE NAVD88 SURVEY FT.

Northing	466032.12	Elevation
Easting	2580720.31	427.87

RECEIVER MODEL	TRIMBLE R10
RECEIVER S/N	5413461432

SESSIONS	DATE:	ObsA	Obs B
VRS	DAY OF YEAR	116	124

	Obs A	ObsB		
START TIME	12:15	08:35		U.T.C.
END TIME	12:18	08:36	X	LOCAL

ANTENNA HEIGHT (SLANT)				
MTRS/FT	2.000 Meters			
	MEASURED	X	FIXED HGT.	

ANTENNA HEIGHT (ARP)			
MTRS/FT	2.000 Meters		
	MEASURED	X	FIXED HGT

ANTENNA			
RADIUS (M)			
Antenna Serial #	5413461432		
Antenna Type	TRM R10	Trimble Integrated Antenna	

TOP OF MONUMENT IS:		X	FLUSH
METERS/FEET			ABOVE GROUND
METERS/FEET			BELOW GROUND

Tip of Paint Arrow

	AERIAL TARGET		PHOTO I.D.
	PUB. BENCH MARK	X	NEW CONTROL
	PUB. CONTROL		BASE STATION

PHOTO

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GPS CONTROL SURVEY
FIELD DATA SHEET

JOB REFERENCE	POINT ID:	UA_02
Allentown, PA (USGS)	Proj. No.:	7494.0425

STATE	PA	COUNTY	LEHIGH	QUAD:	Allentown West (PA)

OPERATOR	ZJL

NAD83(2011) PA SPC SOUTH ZONE NAVD88 SURVEY FT.

Northing	467852.94	Elevation
Easting	2585786.00	364.25

RECEIVER MODEL	TRIMBLE R10
RECEIVER S/N	5413461432

SESSIONS	DATE:	ObsA	Obs B
VRS	DAY OF YEAR	116	124

	Obs A	ObsB		
START TIME	10:13	09:23		U.T.C.
END TIME	10:17	09:23	X	LOCAL

ANTENNA HEIGHT (SLANT)				
MTRS/FT	2.000 Meters			
	MEASURED	X	FIXED HGT.	

ANTENNA HEIGHT (ARP)				
MTRS/FT	2.000 Meters			
	MEASURED	X	FIXED HGT	

ANTENNA			
RADIUS (M)			
Antenna Serial #	5413461432		
Antenna Type	TRM R10	Trimble Integrated Antenna	

TOP OF MONUMENT IS:		X	FLUSH
METERS/FEET			ABOVE GROUND
METERS/FEET			BELOW GROUND

Corner of Paint Stripes

	AERIAL TARGET		PHOTO I.D.
	PUB. BENCH MARK	X	NEW CONTROL
	PUB. CONTROL		BASE STATION

PHOTO

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GPS CONTROL SURVEY
FIELD DATA SHEET

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JOB REFERENCE
Allentown, PA (USGS)

POINT ID:	UA_03
Proj. No.:	7494.0425

STATE	PA	COUNTY	LEHIGH	QUAD:	Allentown West (PA)

OPERATOR	ZJL

NAD83(2011) PA SPC SOUTH ZONE NAVD88 SURVEY FT.

Northing	471368.51
Easting	2588730.80

Elevation
392.22

RECEIVER MODEL	TRIMBLE R10
RECEIVER S/N	5413461432

SESSIONS	DATE:	ObsA	Obs B
VRS	DAY OF YEAR	116	124

	Obs A	ObsB		
START TIME	13:14	09:33		U.T.C.
END TIME	13:17	09:33	X	LOCAL

ANTENNA HEIGHT (SLANT)				
MTRS/FT	2.000 Meters			
	MEASURED	X	FIXED HGT.	

ANTENNA HEIGHT (ARP)				
MTRS/FT	2.000 Meters			
	MEASURED	X	FIXED HGT	

ANTENNA			
RADIUS (M)			
Antenna Serial #	5413461432		
Antenna Type	TRM R10	Trimble Integrated Antenna	

TOP OF MONUMENT IS:		X	FLUSH
METERS/FEET			ABOVE GROUND
METERS/FEET			BELOW GROUND

Corner of Paint Stripes

	AERIAL TARGET		PHOTO I.D.
	PUB. BENCH MARK	X	NEW CONTROL
	PUB. CONTROL		BASE STATION

PHOTO

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GPS CONTROL SURVEY
FIELD DATA SHEET

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JOB REFERENCE
Allentown, PA (USGS)

POINT ID:	UA_04
Proj. No.:	7494.0425

STATE	PA	COUNTY	LEHIGH	QUAD:	Allentown West (PA)

OPERATOR	ZJL

NAD83(2011) PA SPC SOUTH ZONE NAVD88 SURVEY FT.

Northing	467152.92
Easting	2592880.40

Elevation
277.16

RECEIVER MODEL	TRIMBLE R10
RECEIVER S/N	5413461432

SESSIONS	DATE:	ObsA	Obs B
VRS	DAY OF YEAR	116	123

	Obs A	ObsB		
START TIME	09:54	12:05		U.T.C.
END TIME	09:57	12:06	X	LOCAL

ANTENNA HEIGHT (SLANT)				
MTRS/FT	2.000 Meters			
	MEASURED	X	FIXED HGT.	

ANTENNA HEIGHT (ARP)				
MTRS/FT	2.000 Meters			
	MEASURED	X	FIXED HGT	

ANTENNA			
RADIUS (M)			
Antenna Serial #	5413461432		
Antenna Type	TRM R10	Trimble Integrated Antenna	

TOP OF MONUMENT IS:		X	FLUSH
METERS/FEET			ABOVE GROUND
METERS/FEET			BELOW GROUND

Tip of Paint Arrow

	AERIAL TARGET		PHOTO I.D.
	PUB. BENCH MARK	X	NEW CONTROL
	PUB. CONTROL		BASE STATION

PHOTO

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GPS CONTROL SURVEY
FIELD DATA SHEET

JOB REFERENCE	POINT ID:	UA_05
Allentown, PA (USGS)	Proj. No.:	7494.0425

STATE	PA	COUNTY	LEHIGH	QUAD:	Allentown East (PA)

OPERATOR	ZJL

NAD83(2011) PA SPC SOUTH ZONE NAVD88 SURVEY FT.

Northing	473289.00	Elevation
Easting	2596136.95	311.36

RECEIVER MODEL	TRIMBLE R10
RECEIVER S/N	5413461432

SESSIONS	DATE:	ObsA	Obs B
VRS	DAY OF YEAR	116	123

	Obs A	ObsB		
START TIME	14:09	12:58		U.T.C.
END TIME	14:12	12:58	X	LOCAL

ANTENNA HEIGHT (SLANT)				
MTRS/FT	2.000 Meters			
	MEASURED	X	FIXED HGT.	

ANTENNA HEIGHT (ARP)				
MTRS/FT	2.000 Meters			
	MEASURED	X	FIXED HGT	

ANTENNA			
RADIUS (M)			
Antenna Serial #	5413461432		
Antenna Type	TRM R10	Trimble Integrated Antenna	

TOP OF MONUMENT IS:		X	FLUSH
METERS/FEET			ABOVE GROUND
METERS/FEET			BELOW GROUND

Intersection of Paint Stripes

	AERIAL TARGET		PHOTO I.D.
	PUB. BENCH MARK	X	NEW CONTROL
	PUB. CONTROL		BASE STATION

PHOTO

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GPS CONTROL SURVEY
FIELD DATA SHEET

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JOB REFERENCE
Allentown, PA (USGS)

POINT ID:	UA_06
Proj. No.:	7494.0425

STATE	PA	COUNTY	LEHIGH	QUAD:	Allentown East (PA)

OPERATOR	ZJL

NAD83(2011) PA SPC SOUTH ZONE NAVD88 SURVEY FT.

Northing	469095.62
Easting	2602320.63

Elevation
263.47

RECEIVER MODEL	TRIMBLE R10
RECEIVER S/N	5413461432

SESSIONS	DATE:	ObsA	Obs B
VRS	DAY OF YEAR	116	123

	Obs A	ObsB		
START TIME	09:31	12:30		U.T.C.
END TIME	09:34	12:31	X	LOCAL

ANTENNA HEIGHT (SLANT)				
MTRS/FT	2.000 Meters			
	MEASURED	X	FIXED HGT.	

ANTENNA HEIGHT (ARP)			
MTRS/FT	2.000 Meters		
	MEASURED	X	FIXED HGT

ANTENNA			
RADIUS (M)			
Antenna Serial #	5413461432		
Antenna Type	TRM R10	Trimble Integrated Antenna	

TOP OF MONUMENT IS:		X	FLUSH
METERS/FEET			ABOVE GROUND
METERS/FEET			BELOW GROUND

Corner of Paint Stripes

	AERIAL TARGET		PHOTO I.D.
	PUB. BENCH MARK	X	NEW CONTROL
	PUB. CONTROL		BASE STATION

PHOTO

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GPS CONTROL SURVEY
FIELD DATA SHEET

JOB REFERENCE	POINT ID:	UA_07
Allentown, PA (USGS)	Proj. No.:	7494.0425

STATE	PA	COUNTY	LEHIGH	QUAD:	Allentown East (PA)

OPERATOR	ZJL

NAD83(2011) PA SPC SOUTH ZONE NAVD88 SURVEY FT.

Northing	462308.97	Elevation
Easting	2599289.54	347.41

RECEIVER MODEL	TRIMBLE R10
RECEIVER S/N	5413461432

SESSIONS	DATE:	ObsA	Obs B
VRS	DAY OF YEAR	115	123

	Obs A	ObsB		
START TIME	14:14	11:19		U.T.C.
END TIME	14:17	11:20	X	LOCAL

ANTENNA HEIGHT (SLANT)				
MTRS/FT	2.000 Meters			
	MEASURED	X	FIXED HGT.	

ANTENNA HEIGHT (ARP)				
MTRS/FT	2.000 Meters			
	MEASURED	X	FIXED HGT	

ANTENNA			
RADIUS (M)			
Antenna Serial #	5413461432		
Antenna Type	TRM R10	Trimble Integrated Antenna	

TOP OF MONUMENT IS:		X	FLUSH
METERS/FEET			ABOVE GROUND
METERS/FEET			BELOW GROUND

Tip of Paint Arrow

	AERIAL TARGET		PHOTO I.D.
	PUB. BENCH MARK	X	NEW CONTROL
	PUB. CONTROL		BASE STATION

PHOTO

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GPS CONTROL SURVEY
FIELD DATA SHEET

JOB REFERENCE	POINT ID:	UA_08
Allentown, PA (USGS)	Proj. No.:	7494.0425

STATE	PA	COUNTY	LEHIGH	QUAD:	Allentown East (PA)

OPERATOR	ZJL

NAD83(2011) PA SPC SOUTH ZONE NAVD88 SURVEY FT.

Northing	457060.45	Elevation
Easting	2600449.33	402.12

RECEIVER MODEL	TRIMBLE R10
RECEIVER S/N	5413461432

SESSIONS	DATE:	ObsA	Obs B
VRS	DAY OF YEAR	115	123

	Obs A	ObsB		
START TIME	11:57	09:51		U.T.C.
END TIME	12:00	09:51	X	LOCAL

ANTENNA HEIGHT (SLANT)				
MTRS/FT	2.000 Meters			
	MEASURED	X	FIXED HGT.	

ANTENNA HEIGHT (ARP)			
MTRS/FT	2.000 Meters		
	MEASURED	X	FIXED HGT

ANTENNA			
RADIUS (M)			
Antenna Serial #	5413461432		
Antenna Type	TRM R10	Trimble Integrated Antenna	

TOP OF MONUMENT IS:		X	FLUSH
METERS/FEET			ABOVE GROUND
METERS/FEET			BELOW GROUND

Tip of Paint Arrow

	AERIAL TARGET		PHOTO I.D.
	PUB. BENCH MARK	X	NEW CONTROL
	PUB. CONTROL		BASE STATION

PHOTO

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GPS CONTROL SURVEY
FIELD DATA SHEET

JOB REFERENCE	POINT ID:	UA_09
Allentown, PA (USGS)	Proj. No.:	7494.0425

STATE	PA	COUNTY	LEHIGH	QUAD:	Allentown East (PA)

OPERATOR	ZJL

NAD83(2011) PA SPC SOUTH ZONE NAVD88 SURVEY FT.

Northing	461564.94	Elevation
Easting	2606191.84	368.30

RECEIVER MODEL	TRIMBLE R10
RECEIVER S/N	5413461432

SESSIONS	DATE:	ObsA	Obs B
VRS	DAY OF YEAR	115	123

	Obs A	ObsB		
START TIME	12:56	10:30		U.T.C.
END TIME	12:59	10:30	X	LOCAL

ANTENNA HEIGHT (SLANT)				
MTRS/FT	2.000 Meters			
	MEASURED	X	FIXED HGT.	

ANTENNA HEIGHT (ARP)				
MTRS/FT	2.000 Meters			
	MEASURED	X	FIXED HGT	

ANTENNA			
RADIUS (M)			
Antenna Serial #	5413461432		
Antenna Type	TRM R10	Trimble Integrated Antenna	

TOP OF MONUMENT IS:		X	FLUSH
METERS/FEET			ABOVE GROUND
METERS/FEET			BELOW GROUND

Corner of Stop Bar

	AERIAL TARGET		PHOTO I.D.
	PUB. BENCH MARK	X	NEW CONTROL
	PUB. CONTROL		BASE STATION

PHOTO

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GPS CONTROL SURVEY
FIELD DATA SHEET

JOB REFERENCE	POINT ID:	UA_10
Allentown, PA (USGS)	Proj. No.:	7494.0425

STATE	PA	COUNTY	LEHIGH	QUAD:	Allentown East (PA)

OPERATOR	ZJL

RECEIVER MODEL	TRIMBLE R10
RECEIVER S/N	5413461432

NAD83(2011) PA SPC SOUTH ZONE NAVD88 SURVEY FT.

Northing	467031.72
Easting	2610627.05

Elevation
502.68

SESSIONS	DATE:	ObsA	Obs B
VRS	DAY OF YEAR	115	123

	Obs A	ObsB		
START TIME	13:33	10:53		U.T.C.
END TIME	13:36	10:53	X	LOCAL

ANTENNA HEIGHT (SLANT)				
MTRS/FT	2.000 Meters			
	MEASURED	X	FIXED HGT.	

ANTENNA HEIGHT (ARP)				
MTRS/FT	2.000 Meters			
	MEASURED	X	FIXED HGT	

ANTENNA			
RADIUS (M)			
Antenna Serial #	5413461432		
Antenna Type	TRM R10	Trimble Integrated Antenna	

TOP OF MONUMENT IS:		X	FLUSH
METERS/FEET			ABOVE GROUND
METERS/FEET			BELOW GROUND

Corner of Paint Stripes

	AERIAL TARGET		PHOTO I.D.
	PUB. BENCH MARK	X	NEW CONTROL
	PUB. CONTROL		BASE STATION

PHOTO

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GPS CONTROL SURVEY
FIELD DATA SHEET

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JOB REFERENCE
Allentown, PA (USGS)

POINT ID:	UA_11
Proj. No.:	7494.0425

STATE	PA	COUNTY	LEHIGH	QUAD:	Allentown East (PA)

OPERATOR	ZJL

NAD83(2011) PA SPC SOUTH ZONE NAVD88 SURVEY FT.

Northing	474485.57
Easting	2604363.27

Elevation
288.67

RECEIVER MODEL	TRIMBLE R10
RECEIVER S/N	5413461432

SESSIONS	DATE:	ObsA	Obs B
VRS	DAY OF YEAR	117	123

	Obs A	ObsB		
START TIME	09:33	13:23		U.T.C.
END TIME	09:36	13:23	X	LOCAL

ANTENNA HEIGHT (SLANT)				
MTRS/FT				
	MEASURED	X	FIXED HGT.	

ANTENNA			
RADIUS (M)			
Antenna Serial #	5413461432		
Antenna Type	TRM R10	Trimble Integrated Antenna	

ANTENNA HEIGHT (ARP)				
MTRS/FT	2.000 Meters			
	MEASURED	X	FIXED HGT	

TOP OF MONUMENT IS:		X	FLUSH
METERS/FEET			ABOVE GROUND
METERS/FEET			BELOW GROUND

Corner of Paint Stripes

	AERIAL TARGET		PHOTO I.D.
	PUB. BENCH MARK	X	NEW CONTROL
	PUB. CONTROL		BASE STATION

PHOTO

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GPS CONTROL SURVEY
FIELD DATA SHEET

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JOB REFERENCE
Allentown, PA (USGS)

POINT ID:	UA_12
Proj. No.:	7494.0425

STATE	PA	COUNTY	LEHIGH	QUAD:	Catasauqua (PA)

OPERATOR	ZJL

NAD83(2011) PA SPC SOUTH ZONE NAVD88 SURVEY FT.

Northing	479748.66
Easting	2606220.36

Elevation
339.20

RECEIVER MODEL	TRIMBLE R10
RECEIVER S/N	5413461432

SESSIONS	DATE:	ObsA	Obs B
VRS	DAY OF YEAR	117	124

	Obs A	ObsB		
START TIME	11:35	10:23		U.T.C.
END TIME	11:39	10:23	X	LOCAL

ANTENNA HEIGHT (SLANT)				
MTRS/FT	2.000 Meters			
	MEASURED	X	FIXED HGT.	

ANTENNA HEIGHT (ARP)				
MTRS/FT	2.000 Meters			
	MEASURED	X	FIXED HGT	

ANTENNA			
RADIUS (M)			
Antenna Serial #	5413461432		
Antenna Type	TRM R10	Trimble Integrated Antenna	

TOP OF MONUMENT IS:		X	FLUSH
METERS/FEET			ABOVE GROUND
METERS/FEET			BELOW GROUND

Intersection of Parking Stripes

	AERIAL TARGET		PHOTO I.D.
	PUB. BENCH MARK	X	NEW CONTROL
	PUB. CONTROL		BASE STATION

PHOTO

PHOTO:

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GPS CONTROL SURVEY
FIELD DATA SHEET

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JOB REFERENCE
Allentown, PA (USGS)

POINT ID:	UA_13
Proj. No.:	7494.0425

STATE	PA	COUNTY	LEHIGH	QUAD:	Catasauqua (PA)

OPERATOR	ZJL

NAD83(2011) PA SPC SOUTH ZONE NAVD88 SURVEY FT.

Northing	479150.19
Easting	2613781.14

Elevation
359.70

RECEIVER MODEL	TRIMBLE R10
RECEIVER S/N	5413461432

SESSIONS	DATE:	ObsA	Obs B
VRS	DAY OF YEAR	117	124

	Obs A	ObsB		
START TIME	13:26	10:58		U.T.C.
END TIME	13:29	10:58	X	LOCAL

ANTENNA HEIGHT (SLANT)				
MTRS/FT	2.000 Meters			
	MEASURED	X	FIXED HGT.	

ANTENNA HEIGHT (ARP)			
MTRS/FT	2.000 Meters		
	MEASURED	X	FIXED HGT

ANTENNA			
RADIUS (M)			
Antenna Serial #	5413461432		
Antenna Type	TRM R10	Trimble Integrated Antenna	

TOP OF MONUMENT IS:		X	FLUSH
METERS/FEET			ABOVE GROUND
METERS/FEET			BELOW GROUND

Tip of Paint Arrow

	AERIAL TARGET		PHOTO I.D.
	PUB. BENCH MARK	X	NEW CONTROL
	PUB. CONTROL		BASE STATION

PHOTO

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GPS CONTROL SURVEY
FIELD DATA SHEET

JOB REFERENCE	POINT ID:	UA_14
Allentown, PA (USGS)	Proj. No.:	7494.0425

STATE	PA	COUNTY	LEHIGH	QUAD:	Allentown East (PA)

OPERATOR	ZJL

RECEIVER MODEL	TRIMBLE R10
RECEIVER S/N	5413461432

NAD83(2011) PA SPC SOUTH ZONE NAVD88 SURVEY FT.

Northing	477137.78
Easting	2608800.36

Elevation
314.28

SESSIONS	DATE:	ObsA	Obs B
VRS	DAY OF YEAR	117	124

	Obs A	ObsB		
START TIME	13:41	11:53		U.T.C.
END TIME	13:44	11:53	X	LOCAL

ANTENNA HEIGHT (SLANT)				
MTRS/FT	2.000 Meters			
	MEASURED	X	FIXED HGT.	

ANTENNA HEIGHT (ARP)				
MTRS/FT	2.000 Meters			
	MEASURED	X	FIXED HGT	

ANTENNA			
RADIUS (M)			
Antenna Serial #	5413461432		
Antenna Type	TRM R10	Trimble Integrated Antenna	

TOP OF MONUMENT IS:		X	FLUSH
METERS/FEET			ABOVE GROUND
METERS/FEET			BELOW GROUND

Corner of Paint Stripes

	AERIAL TARGET		PHOTO I.D.
	PUB. BENCH MARK	X	NEW CONTROL
	PUB. CONTROL		BASE STATION

PHOTO

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GPS CONTROL SURVEY
FIELD DATA SHEET

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JOB REFERENCE
Allentown, PA (USGS)

POINT ID:	UA_15
Proj. No.:	7494.0425

STATE	PA	COUNTY	LEHIGH	QUAD:	Allentown West (PA)

OPERATOR	ZJL

NAD83(2011) PA SPC SOUTH ZONE NAVD88 SURVEY FT.

Northing	453671.30
Easting	2592508.24

Elevation
395.83

RECEIVER MODEL	TRIMBLE R10
RECEIVER S/N	5413461432

SESSIONS	DATE:	ObsA	Obs B
VRS	DAY OF YEAR	115	123

	Obs A	ObsB		
START TIME	09:13	08:56		U.T.C.
END TIME	09:16	08:56	X	LOCAL

ANTENNA HEIGHT (SLANT)				
MTRS/FT	2.000 Meters			
	MEASURED	X	FIXED HGT.	

ANTENNA HEIGHT (ARP)				
MTRS/FT	2.000 Meters			
	MEASURED	X	FIXED HGT	

ANTENNA			
RADIUS (M)			
Antenna Serial #	5413461432		
Antenna Type	TRM R10	Trimble Integrated Antenna	

TOP OF MONUMENT IS:		X	FLUSH
METERS/FEET			ABOVE GROUND
METERS/FEET			BELOW GROUND

Corner of Parking Stripes

	AERIAL TARGET		PHOTO I.D.
	PUB. BENCH MARK	X	NEW CONTROL
	PUB. CONTROL		BASE STATION

PHOTO

PHOTO:

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GPS CONTROL SURVEY
FIELD DATA SHEET

JOB REFERENCE	POINT ID:	UA_16
Allentown, PA (USGS)	Proj. No.:	7494.0425

STATE	PA	COUNTY	LEHIGH	QUAD:	Allentown East (PA)

OPERATOR	ZJL

NAD83(2011) PA SPC SOUTH ZONE NAVD88 SURVEY FT.

Northing	469493.96	Elevation
Easting	2598164.83	390.11

RECEIVER MODEL	TRIMBLE R10
RECEIVER S/N	5413461432

SESSIONS	DATE:	ObsA	Obs B
VRS	DAY OF YEAR	116	123

	Obs A	ObsB		
START TIME	09:43	13:10		U.T.C.
END TIME	09:46	13:11	X	LOCAL

ANTENNA HEIGHT (SLANT)				
MTRS/FT	2.000 Meters			
	MEASURED	X	FIXED HGT.	

ANTENNA HEIGHT (ARP)				
MTRS/FT	2.000 Meters			
	MEASURED	X	FIXED HGT	

ANTENNA			
RADIUS (M)			
Antenna Serial #	5413461432		
Antenna Type	TRM R10	Trimble Integrated Antenna	

TOP OF MONUMENT IS:		X	FLUSH
METERS/FEET			ABOVE GROUND
METERS/FEET			BELOW GROUND

Corner of Parking Stripe

	AERIAL TARGET		PHOTO I.D.
	PUB. BENCH MARK	X	NEW CONTROL
	PUB. CONTROL		BASE STATION

PHOTO

PHOTO:

Appendix G

Ortho Accuracy Analyst Report

CompassData, Inc.
12353 E. Easter Ave.
Centennial, CO 80112
(303) 627-4058

CompassAA™

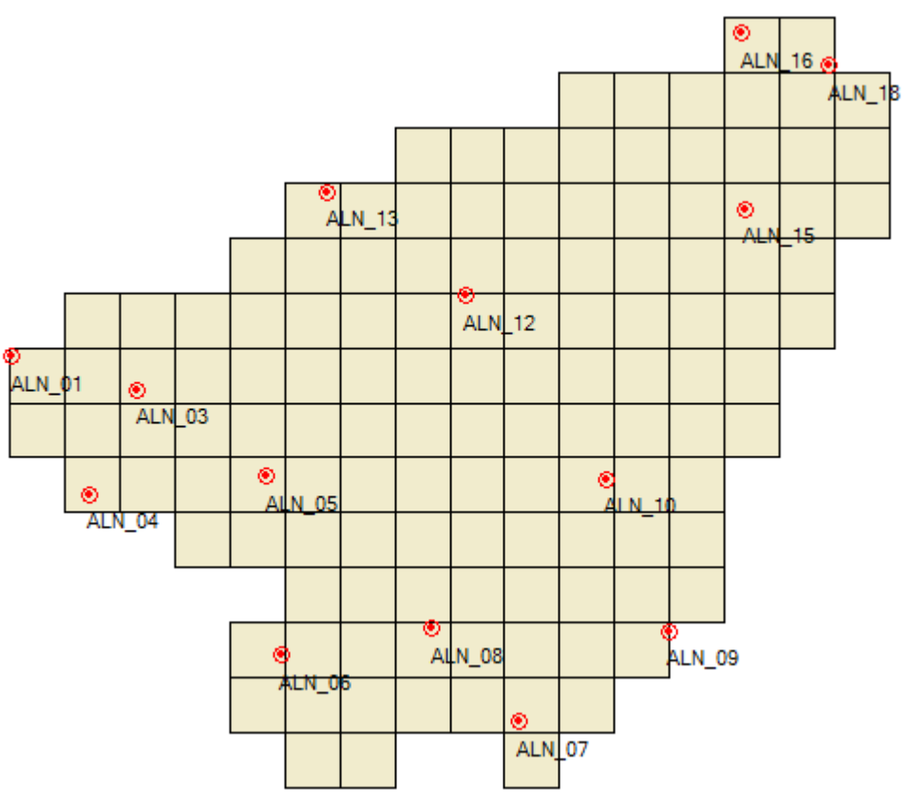
Project Information

Prepared By: Matthew McClure
Project Name: Allentown
Sensor Info: DMC
Sensor Resolution: 0.25
Vendor Name: Quantum Spatial Inc.
Date of Aquisition: Start: 3/30/2016 Finish: 3/30/2016

Metadata Information

Index File Name: AllentownProjectTiles_reduced_to_touching_AOI.shp
# of Polygons: 129
# of Matching Images: 129
Polygon ID: IMFNAME
Units: Feet
Image Folder Path: S:\ORTHO\27136_Allentown\new_AT_sheets6_accuracy_cks
Threshold: CE90: 0.568
Scaling Used: 1:50

Tiled-Image Area



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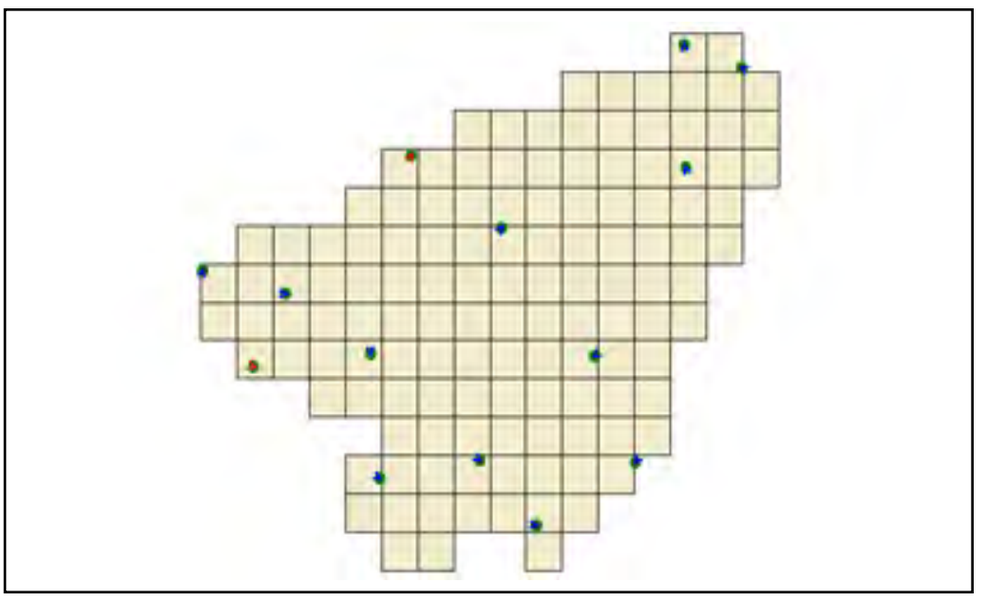
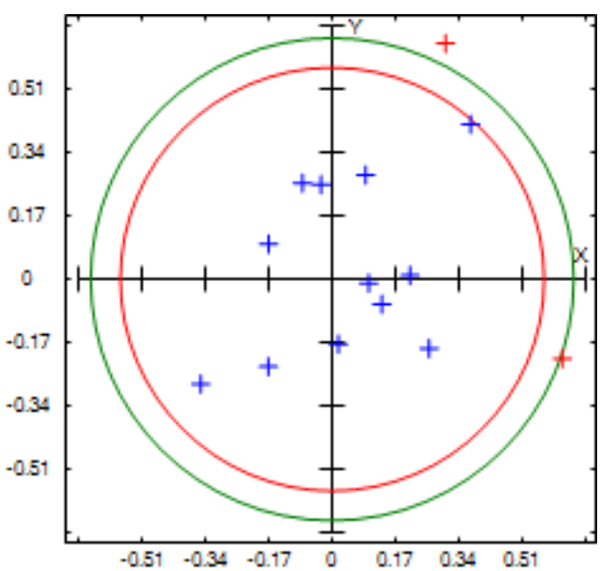
Vector Offset



Scaling Factor: 200

Circular Error



Error Statistics

Min ΔX:	-0.353
Min ΔY:	-0.281
Max ΔX:	0.617
Max ΔY:	0.633
Mean ΔX:	0.092
Mean ΔY:	0.056
RmseX:	0.26
RmseY:	0.273
RmseH:	0.377
NSSDA:	0.652
No. Obs.:	14

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Coordinates and Offsets of Analyzed Locations

		ID						
			Survey X	Survey Y	Photo X	Photo Y	ΔX	ΔY
1)	☑	ALN_01						
			2577570.85	469597.02	2577570.939	469597.3	0.089	0.28
2)	☑	ALN_03						
			2583295.07	468088.98	2583295.278	468088.991	0.208	0.011
3)	☑	ALN_04						
			2581080.34	463313.25	2581080.957	463313.037	0.617	-0.213
4)	☑	ALN_05						
			2589166.45	464165.74	2589166.467	464165.566	0.017	-0.174
5)	☑	ALN_06						
			2589813.37	456030.81	2589813.503	456030.743	0.133	-0.067
6)	☑	ALN_07						
			2600618.92	452988.26	2600619.018	452988.249	0.098	-0.011
7)	☑	ALN_08						
			2596701.24	457224.94	2596701.5	457224.755	0.26	-0.185
8)	☑	ALN_09						
			2607448.43	457082.89	2607448.259	457082.655	-0.171	-0.235
9)	☑	ALN_10						
			2604625.84	464012.51	2604625.487	464012.229	-0.353	-0.281
10)	☑	ALN_12						
			2598221.07	472369.33	2598221.441	472369.746	0.371	0.416

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		ID						
			Survey X	Survey Y	Photo X	Photo Y	ΔX	ΔY
11)	☑	ALN_13						
			2591950.49	477074.67	2591950.794	477075.303	0.304	0.633
12)	☑	ALN_15						
			2610917.81	476307.26	2610917.731	476307.518	-0.079	0.258
13)	☑	ALN_16						
			2610807.88	484307.75	2610807.85	484308.004	-0.03	0.254
14)	☑	ALN_18						
			2614775.81	482806.55	2614775.639	482806.644	-0.171	0.094

Point ALN_01:

X1: 2577570.85 Y1: 469597.02 X2: 2577570.939 Y2: 469597.3 Delta X: 0.089 Delta Y: 0.28

Point ALN_03:

X1: 2583295.07 Y1: 468088.98 X2: 2583295.278 Y2: 468088.991 Delta X: 0.208 Delta Y: 0.011

Point ALN_04:

X1: 2581080.34 Y1: 463313.25 X2: 2581080.957 Y2: 463313.037 Delta X: 0.617 Delta Y: -0.213

Point ALN_05:

X1: 2589166.45 Y1: 464165.74 X2: 2589166.467 Y2: 464165.566 Delta X: 0.017 Delta Y: -0.174

Point ALN_06:

X1: 2589813.37 Y1: 456030.81 X2: 2589813.503 Y2: 456030.743 Delta X: 0.133 Delta Y: -0.067

Point ALN_07:

X1: 2600618.92 Y1: 452988.26 X2: 2600619.018 Y2: 452988.249 Delta X: 0.098 Delta Y: -0.011

Point ALN_08:

X1: 2596701.24 Y1: 457224.94 X2: 2596701.5 Y2: 457224.755 Delta X: 0.26 Delta Y: -0.185

Point ALN_09:

X1: 2607448.43 Y1: 457082.89 X2: 2607448.259 Y2: 457082.655 Delta X: -0.171 Delta Y: -0.235

Point ALN_10:

X1: 2604625.84 Y1: 464012.51 X2: 2604625.487 Y2: 464012.229 Delta X: -0.353 Delta Y: -0.281

Point ALN_12:

X1: 2598221.07 Y1: 472369.33 X2: 2598221.441 Y2: 472369.746 Delta X: 0.371 Delta Y: 0.416

Point ALN_13:

X1: 2591950.49 Y1: 477074.67 X2: 2591950.794 Y2: 477075.303 Delta X: 0.304 Delta Y: 0.633

Point ALN_15:

X1: 2610917.81 Y1: 476307.26 X2: 2610917.731 Y2: 476307.518 Delta X: -0.079 Delta Y: 0.258

Point ALN_16:

X1: 2610807.88 Y1: 484307.75 X2: 2610807.85 Y2: 484308.004 Delta X: -0.03 Delta Y: 0.254

Point ALN_18:

X1: 2614775.81 Y1: 482806.55 X2: 2614775.639 Y2: 482806.644 Delta X: -0.171 Delta Y: 0.094