

# AERIAL TRIANGULATION REPORT



## INDIANA STATEWIDE IMAGERY PROGRAM INDIANA OFFICE OF TECHNOLOGY TIER 2 - BLOCK 6

Woolpert Project Number: 72134  
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## TIER 2 - BLOCK 6

### INDIANA STATEWIDE IMAGERY PROGRAM

#### WOOLPERT PROJECT #72134

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# AERIAL TRIANGULATION REPORT

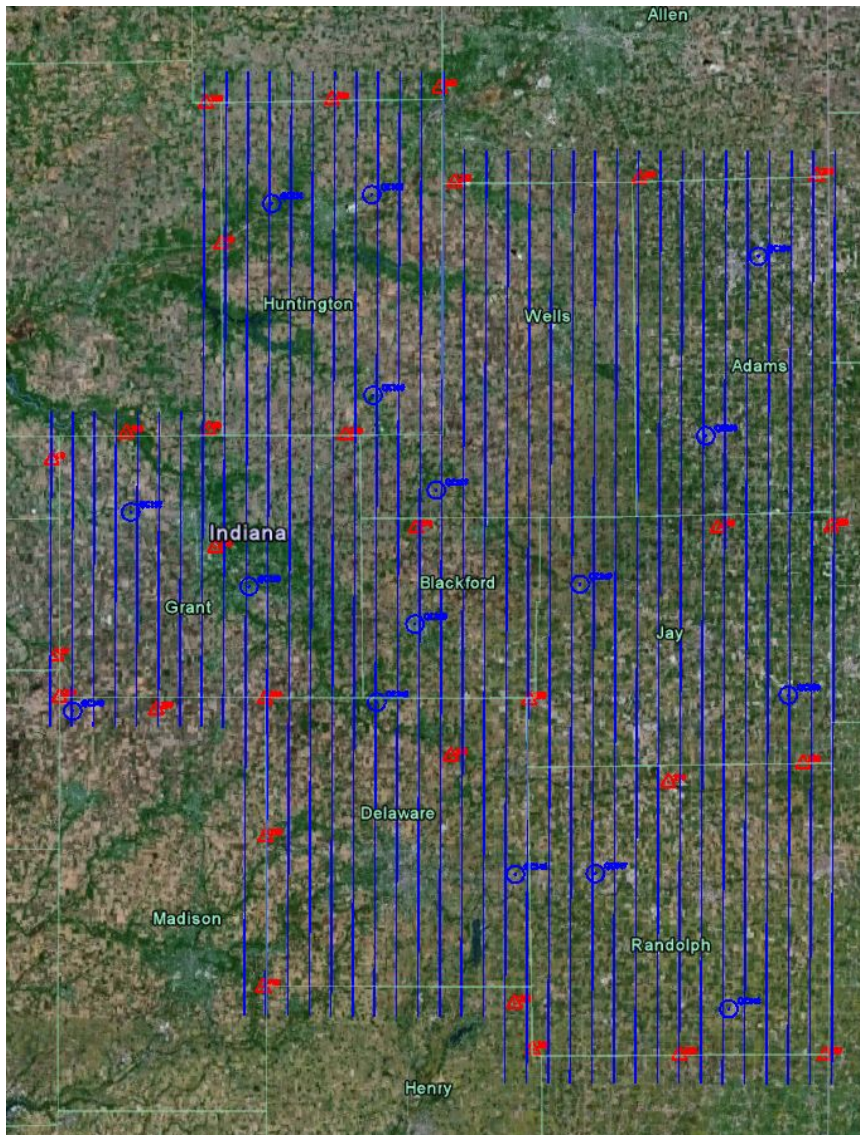
## INTRODUCTION

This report contains an outline of the photogrammetric aerial triangulation (AT) process that supported the 2012 Indiana Statewide Imagery Program for Tier 2 - Block 6, under the direction of the Indiana Office of Technology.

## PROJECT AREA

The project area is defined within this report as Indiana Statewide Tier 2 - Block 6, and visually shown below:

### INDIANA STATEWIDE TIER 2 - BLOCK 6



## PURPOSE OF AERIAL TRIANGULATION

Aerial triangulation is a method of ground control extension or densification performed mathematically and in conjunction with a limited number of ground control points, Airborne GPS data, and inertial measurement data to control aerial imagery such that it may be utilized to measure 3D information about features on or above the ground.

## DATES OF IMAGE ACQUISITION

Aerial imagery was acquired using the Leica ADS51 digital sensors. A total of six (6) missions were completed for the entire project Tier as follows:

Julian Day	Imagery Flights	Sensor(s)	Date
48	11-21	1326	February 17, 2012
60	9-11	106	February 29, 2012
67	35-37	1326	March 7, 2012
69	1-10, 22-24	1326	March 9, 2012
70	25-35	1326	March 10, 2012
71	36-37	1326	March 11, 2012

## SENSOR DESCRIPTION

All data was acquired using the Leica ADS51 digital sensors, serial numbers 1326 and 106. Both the FCIR and RGB bands were acquired simultaneously. The maximum acquisition ground sampling distance was 0.98-foot with the final deliverable pixels being produced at 1.0 -foot.

The band configurations are as outlined:

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Sensor #1326		
<b>Calibration Date: August 9, 2010</b>		
BLUE NADIR	NIR NADIR	PANF02
GREEN NADIR	PANB14	
RED NADIR	PANF27	

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Sensor #106		
<b>Calibration Date: June 26, 2007</b>		
BLUE NADIR	NIR NADIR	PANF02
GREEN NADIR	PANB14	
RED NADIR	PANF27	

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## PROCESSING SOFTWARE

The software utilized for the digital image processing and aerial triangulation, developed by Leica GeoSystems, was XPro version 5.0.

## PROCESSING METHODOLOGY

Indiana Statewide Tier 2 - Block 6 was created using Leica's XPro software and is based on project specifications, control point locations and a suitable number of lines for the block. Indiana Statewide Tier 2 - Block 6 contains a good distribution of control points within its boundaries.

Every band for the required flight lines is added to the project applying the processed position and orientation data. This creates metadata files and an orientation data file for each band giving the imagery its raw position and orientation.

The aerial triangulation process uses only the Level 0 panchromatic imagery bands PANB14, PANF27, and PANF02 which are created by XPro. The aerial triangulation process is similar to conventional operations, where the Level 0 panchromatic imagery is passed through Automatic Point Measurement, the resulting tie points and ground control is adjusted using CAP-A and ORIMA software. Blunders are removed and the block is analyzed for weak network areas, and if required, manual points are added. The final adjustment output consists of precise orientation data files for each band, calibration parameters and metadata. The imagery can now be rectified to a DEM which removes any relief displacement which may be present. During this processing stage, we can set the required ground sampling distance (GSD), 8 bit or 16 bit imagery, and apply a tonal curve. The ortho-rectified imagery is commonly referred to as Level 2 imagery.

## GROUND CONTROL USED IN TRIANGULATION

Ground Control Used in Triangulation			
Point ID	X ft	Y ft	Z ft
57	272165.3	1884210	853.479
60	270347.3	1959138	824.833
61	330537.9	1970862	881.126
75	335016.4	2041622	730.822
227	566733.7	1733560	1194.415
228	511098.6	1733261	1216.75
229	455105.4	1735078	1155.03
230	448203.8	1752739	1094.616
231	351994.7	1758265	918.47
253	352870.9	1815794	899.755
254	273571.9	1868521	863.29
255	310906.3	1863969	895.141
256	352516.7	1868155	891.085
258	557880.3	1844612	1026.711
259	568330.1	1934545	854.48
260	562208.8	2068202	803.854
261	494673.5	2066731	798.35
262	424188.1	2065231	780.626
263	418325.7	2101565	834.938
264	376955	2096771	840.964
266	298937.5	1969452	800.868
269	328736.7	2095583	856.327
270	525125.8	1933990	845.361

Ground Control Used in Triangulation			
Point ID	X ft	Y ft	Z ft
271	410024.6	1933515	868.569
272	333291.1	1925826	842.24
273	423662.3	1846673	905.362
274	506667.6	1837263	1000.18
294	382961.4	1968879	841.497
295	453593.5	1868300	938.841

## AT BLOCK STATISTICAL DATA

Control Point Residuals			
Point ID	X ft	Y ft	Z ft
227	0.0023	-0.0018	-0.0009
228	0.0027	-0.0043	0.0007
229	0.0008	-0.0027	0.0011
230	-0.0025	0.0027	-0.0009
231	-0.0021	0.0002	0.0002
253	0.0023	-0.0011	-0.0001
254	-0.0029	-0.0032	-0.001
255	-0.0001	-0.0007	0.0002
256	0.002	0.0008	0.0009
258	-0.0007	0.0056	0.002
259	-0.004	-0.0028	0
260	0.002	-0.0006	0.0005
261	-0.0008	0.0007	-0.0002
262	-0.0031	0.0029	0.0003
263	0.0029	-0.0043	-0.0003
264	0.0003	-0.002	0.0009
266	0.0007	0.0033	-0.0005
269	-0.0014	0.0001	0.0001
270	0.0002	-0.0006	-0.0011
271	0.0022	0.006	-0.0001
272	-0.0092	0.0029	0.0026
273	-0.0012	-0.0015	-0.001
274	-0.0026	0.0023	-0.0012
294	0.0022	-0.0004	-0.0021
295	0.0021	0.0015	0
57	0.0039	0.0035	0.0014
60	-0.001	-0.0024	0.0002
61	0.0042	-0.0049	-0.002
75	0.0007	0.0007	0.0003



## SUMMARY

The final RMSE (Root Mean Square Error) residuals on the ground control points are as follows:

	X	Y	Z
RMS	0.001967	0.001944	0.000667
RMS P	0.002766		

The RMSE P values fall well within the industry and National Map Accuracy Standards for DOI mapping at 1"=200' scale.

## QC RESULTS

The Indiana Statewide Tier 2 - Block 6 QC Point Horizontal Accuracy Static Worksheet listed below shows quality-controlled point checks and analysis.

Point number	Point description	x (Survey)	x (AT)	diff in x	(diff in x) <sup>2</sup>	y (Survey)	y (AT)	diff in y	(diff in y) <sup>2</sup>	(diff in x) <sup>2</sup> + (diff in y) <sup>2</sup>
"QC143"	target	278701.151	278701.057	0.094	0.009	1863330.165	1863330.054	0.111	0.012	0.021
"QC145"	target	395358.851	395359.105	-0.254	0.065	1867265.234	1867265.370	-0.136	0.018	0.083
"QC146"	target	448453.700	448453.516	0.184	0.034	1801893.369	1801893.413	-0.044	0.002	0.036
"QC147"	target	478938.947	478938.841	0.106	0.011	1802361.958	1802361.949	0.009	0.000	0.011
"QC148"	target	529906.083	529905.824	0.259	0.067	1751018.976	1751018.993	-0.017	0.000	0.068
"QC149"	target	472757.360	472757.503	-0.143	0.020	1912501.328	1912500.961	0.367	0.135	0.155
"QC150"	target	552174.964	552175.106	-0.142	0.020	1870576.897	1870576.818	0.079	0.006	0.027
"QC151"	target	354263.280	354263.465	-0.185	0.034	2057248.177	2057247.873	0.304	0.092	0.127
"QC152"	target	300738.023	300738.254	-0.231	0.053	1939344.579	1939344.592	-0.013	0.000	0.053
"QC153"	target	346342.535	346342.758	-0.223	0.050	1911106.214	1911105.912	0.302	0.091	0.141
"QC154"	target	540109.849	540110.057	-0.208	0.043	2037517.186	2037516.904	0.282	0.080	0.123
"QC155"	target	520435.208	520435.240	-0.032	0.001	1969121.991	1969121.804	0.187	0.035	0.036
"QC157"	target	417792.795	417792.638	0.157	0.025	1948064.367	1948063.953	0.414	0.171	0.196
"QC158"	target	392487.768	392487.920	-0.152	0.023	2060703.512	2060703.026	0.486	0.236	0.259
"QC159"	target	393427.586	393427.586	0.000	0.000	1984159.930	1984159.931	-0.001	0.000	0.000
"QC160"	target	409827.355	409827.478	-0.123	0.015	1897030.060	1897029.741	0.319	0.102	0.117
									sum	1.453
									average	0.091
									RMSE	0.301
									NSSDA	0.522