# AERIAL TRIANGULATION REPORT

# INDIANA STATEWIDE IMAGERY PROGRAM
# INDIANA OFFICE OF TECHNOLOGY

## TIER 2 - BLOCK 5

Woolpert Project Number: 72134
July 2012

**WOOLPERT**
DESIGN | GEOSPATIAL | INFRASTRUCTURE

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## INDIANA STATEWIDE IMAGERY PROGRAM

## WOOLPERT PROJECT #72134

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# Summary of Contents

# 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 5, 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 5, and visually shown below:

### INDIANA STATEWIDE TIER 2 - BLOCK 5

# 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 two (2) missions were completed for the entire project Tier as follows:

| Julian Day | Imagery Flights | Sensor(s) | Date |
|---|---|---|---|
| 75 | 1-7 | 1326 | March 15, 2012 |
| 81 | 7-18 | 106 | March 21, 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:

| Sensor #1326 | | |
|---|---|---|
| **Calibration Date: August  9, 2010** | | |
| BLUE NADIR | NIR NADIR | PANF02 |
| GREEN NADIR | PANB14 | |
| RED NADIR | PANF27 | |

| Sensor #106 | | |
|---|---|---|
| **Calibration Date: June 26, 2007** | | |
| BLUE NADIR | NIR NADIR | PANF02 |
| GREEN NADIR | PANB14 | |
| RED NADIR | PANF27 | |

# 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 5 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 5 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 |
| 80 | 329196.1 | 2371727 | 813.527 |
| 85 | 331544.7 | 2306842 | 916.368 |
| 268 | 330230.3 | 2285678 | 875.733 |
| 285 | 457258 | 2364523 | 947.045 |
| 286 | 455625.7 | 2328909 | 988.963 |
| 291 | 458743.9 | 2291593 | 956.19 |
| 292 | 393352.2 | 2372056 | 873.119 |
| 293 | 400243.6 | 2287069 | 928.998 |

# AT BLOCK STATISTICAL DATA

| Control Point Residuals | | | |
|---|---|---|---|
| Point ID | X ft | Y ft | Z ft |
| 268 | -0.0015 | 0.0005 | -0.0001 |
| 285 | 0.0036 | -0.0028 | -0.0002 |
| 286 | 0.0002 | -0.0013 | 0.0013 |
| 291 | 0.0027 | 0.0034 | -0.0009 |
| 292 | -0.0015 | -0.0018 | -0.0003 |
| 293 | -0.0019 | 0.0038 | 0.0002 |
| 80 | -0.0011 | -0.0022 | -0.0003 |
| 85 | -0.0005 | 0.0004 | 0.0002 |
| 268 | -0.0015 | 0.0005 | -0.0001 |

# SUMMARY

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

|  | X | Y | Z |
|---|---|---|---|
| RMS | 0.001611 | 0.001856 | 0.0004 |
| RMS P | 0.002457 | | |

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 5 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)$^2$ | y (Survey) | y (AT) | diff in y | (diff in y)$^2$ | (diff in x)$^2$ + (diff in y)$^2$ |
|---|---|---|---|---|---|---|---|---|---|---|
| "QC164" | target | 425468.67 | 425468.4998 | 0.170 | 0.029 | 2357894.21 | 2357893.351 | 0.859 | 0.738 | 0.767 |
| "QC165" | target | 351808.884 | 351808.8936 | -0.010 | 0.000 | 2346499.475 | 2346498.89 | 0.585 | 0.342 | 0.342 |
| "QC166" | target | 395683.351 | 395683.5258 | -0.175 | 0.031 | 2305184.104 | 2305183.914 | 0.190 | 0.036 | 0.067 |
| | | | | | | | | | sum | 1.176 |
| | | | | | | | | | average | 0.392 |
| | | | | | | | | | RMSE | 0.626 |
| | | | | | | | | | NSSDA | 1.084 |
| | | | | | | | | | | |
| | | | | | | | | | | |