

# THRASHER

## 2019 Harrison County Aerial Triangulation And Ground Control Report

Prepared by:

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The Thrasher Group (TTG) has successfully completed the aerial triangulation (AT) for the countywide spring flight.

Using semi-automatic analytical aerial triangulation procedures, TTG determined the exterior orientation parameters for each exposure in the photography that covers the project area.

The results of the final adjustments are sufficient to enable TTG to photogrammetrically produce orthophotos from the photography. The AT solution ensures that the project data will meet or exceed the accuracy expectation as outlined in the contract.

#### Ground Control

The ground control network was designed to provide a geometrically strong horizontal and vertical control system within the project area.

Sufficiently identified ground control points (GCPS) were surveyed within the block to provide horizontal and vertical control.

#### Aerial Photography

Aerial photography for the project was captured between February 16, 2019 and March 12, 2019.

The photography was acquired with an approximate 60 percent overlap and an approximate 30 percent side lap. The flight altitude of the photography was approximately 7,700 feet above mean terrain.

#### Airborne GPS

Airborne-GPS (ABGPS) data was captured during the acquisition of the aerial photography. An appropriate GPS antenna was mounted on each aircraft used on the project, and the relationship between the antenna phase centers and the camera perspective centers was then determined through close-range survey techniques. Dual frequency, geodetic quality receivers were utilized for the data collection.

The GPS data was post-processed, and the appropriate interpolations, transformations and reductions were applied to derive the camera's spatial position referenced to the World Geodetic System of 1984 (WGS84) at each instant of exposure.

#### Flight

The flight plan was comprised of 36 flight lines. The designed ground sample distance per pixel was 10 centimeters.

The block consisted of a total of 2,532 images.

A fully equipped aircraft was employed for the photographic mission. In the aircraft, the instrumentation utilized in the acquisition of aerial photography and ABGPS data comprised of a Zeiss DMC III aerial camera featuring forward motion compensation, and a GPS Novatel Span Receiver with a collection rate of one half-second.

During each flight, every exposure triggered by each camera was recorded in the associated GPS data file as an external event. A time stamp for each event later allowed the interpolation of the camera position at each instant or exposure.

## Aerial Triangulation

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

The aerial triangulation was performed utilizing the ground control and the airborne GPS-assisted techniques. These data are then introduced along with the reduced image coordinates, as observations, into a combined three-dimensional simultaneous least squares adjustment by bundles. This approach allows a substantial reduction in the amount of ground control required for the AT solutions.

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

Internal software checks were performed to detect gross errors in the photo measurements.

## Bundle Adjustment

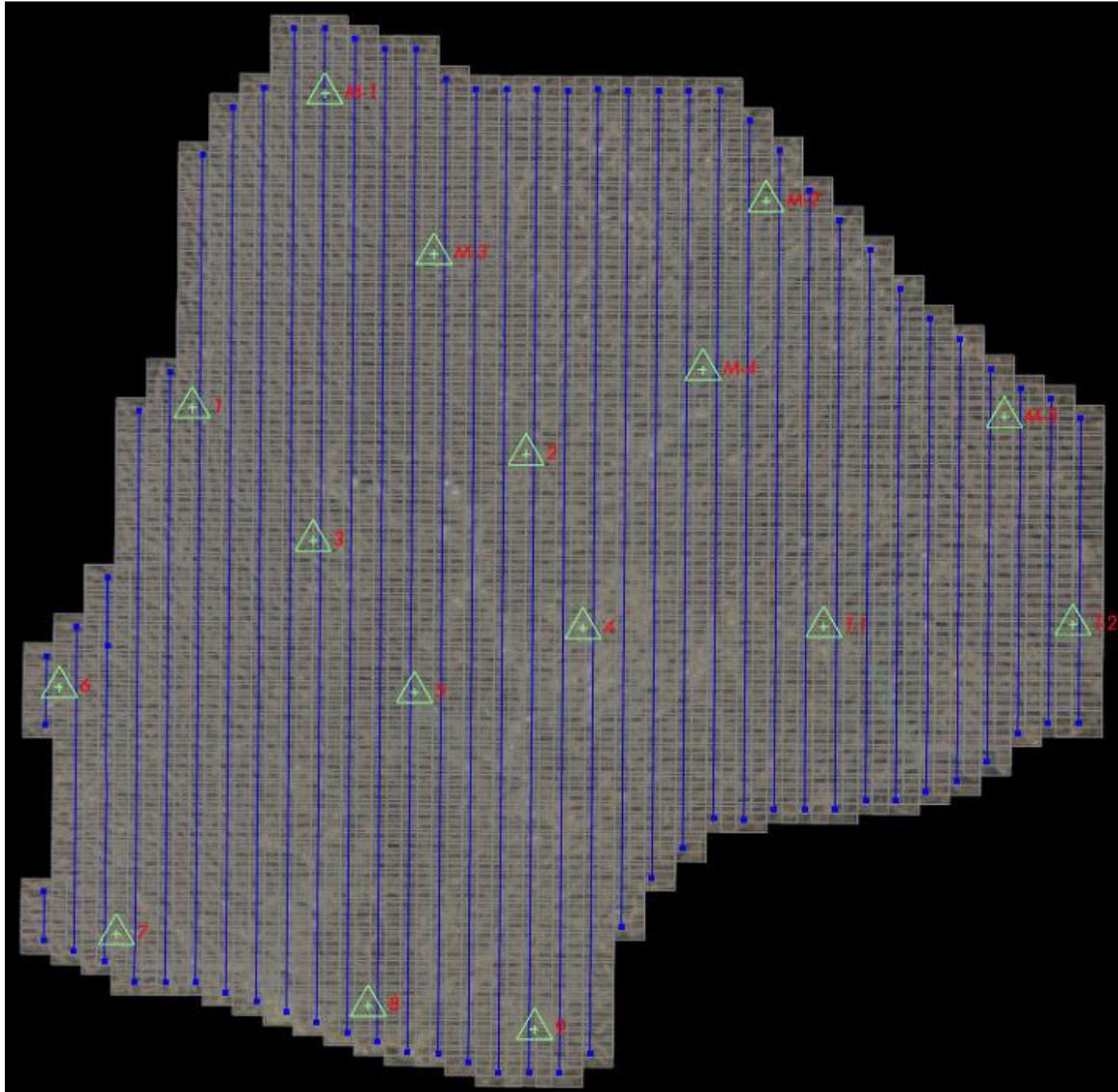
The surveyed control, along with the reduced image coordinates, served as input into the 'combined' block adjustment. Three-dimensional, simultaneous least squares adjustments by bundles, were undertaken using Match-AT bundle adjustment software. This bundle block adjustment software has proven to be a very rigorous and stable platform.

Sixteen control points were used to constrain the AT solution. The sigma naught is a significant indicator of the quality of the adjustment. The sigma value derived by the block adjustment is the root mean square of all photo measurement residuals for the entire block. The lower the sigma naught, the less tension within the AT solution. The sigma naught for this adjustment was 0.4 microns. The

residuals of the control points from measured position to surveyed position are as follows:

Residual point x y z (ft.)

1	0.098	0.085	0.088
2	-0.105	-0.018	0.099
3	-0.044	0.264	0.108
4	0.111	0.070	0.189
5	0.105	0.031	0.192
6	0.071	0.194	-0.095
7	0.098	-0.008	-0.642
8	0.236	-0.034	0.257
9	0.154	0.020	0.386
M-1	0.032	0.088	-0.006
M-2	-0.155	0.065	0.008
M-3	-0.199	0.076	0.098
M-4	0.017	0.009	0.139
M-5	-0.166	0.032	-0.560
T-1	-0.023	0.041	-0.275
T-2	0.015	-0.102	-0.311



### GNSS CONTROL POINT LOCATION SHEET

Horizontal Datum: NAD83	Vertical Datum: NAVD88
Projection: WV North (4701)	Geoid: Geoid12B
Precisions (ft): H: 0.0175 V: 0.065 Post Processed	Method: Static
Date: 3/21/2019	Operator: Lynch
Location: Folsom, Marion County, WV	

**1**

Northing (ft): 346537.425

Easting (ft): 1684313.193

Elevation (ft): 1104.049

#### Detailed Description:

Corner of concrete at seam in driveway 260 ft N of the intersection of Rt. 20 and Rt. 20/33.



### GNSS CONTROL POINT LOCATION SHEET

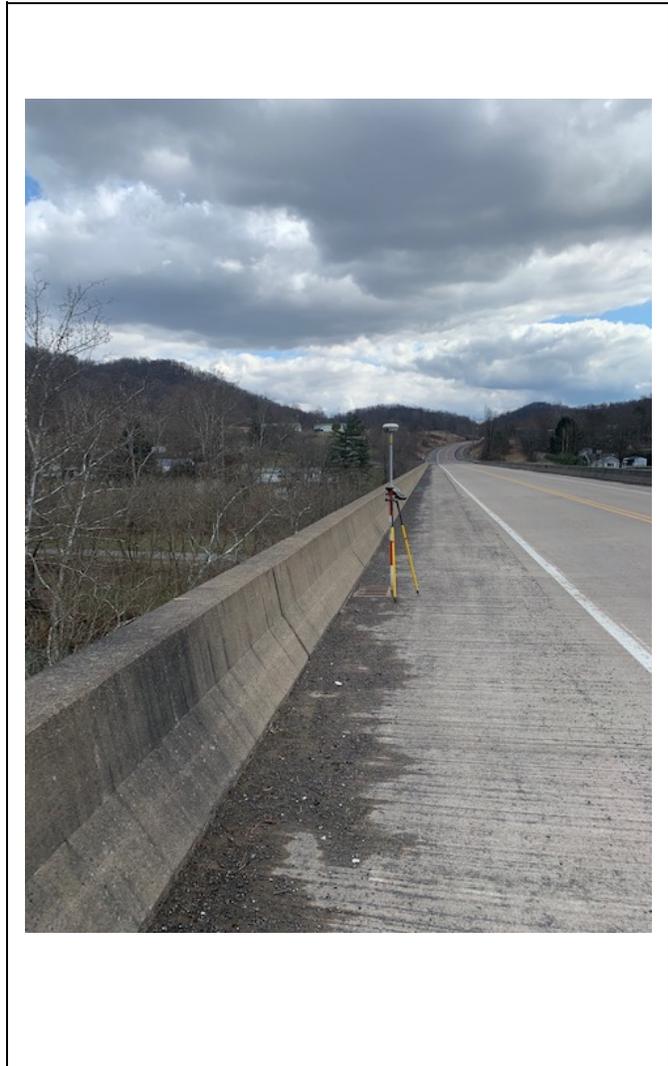
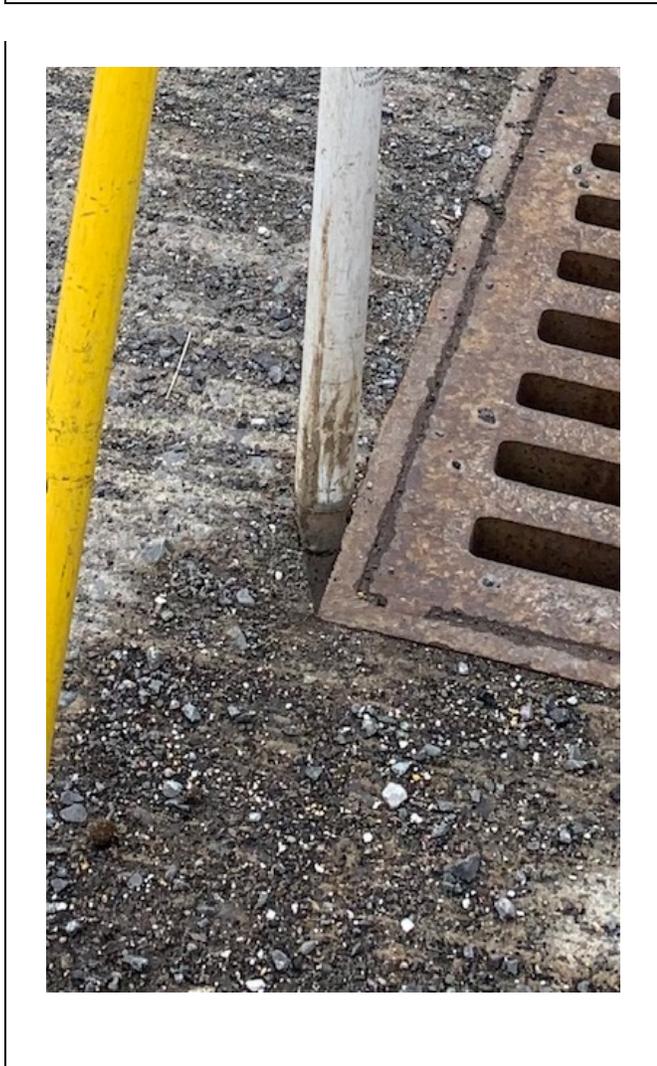
Horizontal Datum: NAD83	Vertical Datum: NAVD88
Projection: WV North (4701)	Geoid: Geoid12B
Precisions (ft): H: 0.603ft V: 0.075ft @95%Conf	Method: VRS
Date: 3/18/2019	Operator: Lynch
Location: Enterprise, Marion County, WV	

2

Northing (ft):	337380.408
Easting (ft):	1749251.511
Elevation (ft):	940.201

**Detailed Description:**

SW corner of drop inlet on Rt. 19/2, on bridge spanning West Fork River, 470 ft from the intersection of Rt. 19/2, Rt. 19/44 and US Rt. 19.



### GNSS CONTROL POINT LOCATION SHEET

Horizontal Datum: NAD83	Vertical Datum: NAVD88
Projection: WV North (4701)	Geoid: Geoid12B
Precisions (ft): H: 0.0115 V: 0.023 Post Processed	Method: Static
Date: 3/21/2019	Operator: Lynch
Location: Dola, WV	

3

Northing (ft):	225507.527
Easting (ft):	1750889.288
Elevation (ft):	1140.866

**Detailed Description:**

Corner of concrete at the SW intersection of the pad and sidewalk at the Dola Miner's Memorial



### GNSS CONTROL POINT LOCATION SHEET

Horizontal Datum: NAD83	Vertical Datum: NAVD88
Projection: WV North (4701)	Geoid: Geoid12B
Precisions (ft): H: 0.054ft V: 0.066ft @95%Conf	Method: VRS
Date: 3/18/2019	Operator: Lynch
Location: White Oaks Business Park, Harrison County, WV	

**4**

Northing (ft):	303535.823
Easting (ft):	1760316.456
Elevation (ft):	1221.066

#### Detailed Description:

Corner of concrete pad at the end of the sidewalk at the intersection of Shaner Drive and South View Drive in White Oaks Business Park.



### GNSS CONTROL POINT LOCATION SHEET

Horizontal Datum: NAD83	Vertical Datum: NAVD88
Projection: WV North (4701)	Geoid: Geoid12B
Precisions (ft): H: 0.058 ft V: 0.078 ft @95%Conf	Method: VRS
Date: 3/19/2019	Operator: Lynch
Location: Clarksburg, Harrison County, WV	

**5**

Northing (ft):	291089.435
Easting (ft):	1727534.845
Elevation (ft):	1066.829

Detailed Description:

SE corner of tennis court boundary line in North View Park



### GNSS CONTROL POINT LOCATION SHEET

Horizontal Datum: NAD83	Vertical Datum: NAVD88
Projection: WV North (4701)	Geoid: Geoid12B
Precisions (ft): H: 0.059ft V: 0.080ft @95%Conf	Method: VRS
Date: 3/18/2019	Operator: Lynch
Location: Salem, Marion County, WV	

**6**

Northing (ft):	292106.199
Easting (ft):	1658492.7
Elevation (ft):	1162.788

#### Detailed Description:

NE corner of concrete where the sidewalk intersects with the blacktop parking lot of the West Union Bank - Salem Office



### GNSS CONTROL POINT LOCATION SHEET

Horizontal Datum: NAD83	Vertical Datum: NAVD88
Projection: WV North (4701)	Geoid: Geoid12B
Precisions (ft): H: 0.0055 f V: 0.039 ft Post Processed	Method: Static
Date: 3/25/2019	Operator: Lynch
Location: Kinckeloe, Marion County, WV	

**7**

Northing (ft): 293934.546

Easting (ft): 1669546.681

Elevation (ft): 1073.799

#### Detailed Description:

NE corner of concrete driveway where  
blacktop meets the concrete



### GNSS CONTROL POINT LOCATION SHEET

Horizontal Datum: NAD83	Vertical Datum: NAVD88
Projection: WV North (4701)	Geoid: Geoid12B
Precisions (ft): H: 0.049 V: 0.057 @95%Conf Method:	VRS
Date: 3/19/2019	Operator: Lynch
Location: McWhorter, Harrison County, WV	

**8**

Northing (ft):	229997.202
Easting (ft):	1718523.107
Elevation (ft):	1142.853

Detailed Description:

NE corner of concrete



### GNSS CONTROL POINT LOCATION SHEET

Horizontal Datum: NAD83	Vertical Datum: NAVD88
Projection: WV North (4701)	Geoid: Geoid12B
Precisions (ft): H: 0.017 V: 0.039 <small>Post Processed</small>	Method: Static
Date: 3/25/2019	Operator: Lynch
Location: Harrison County, WV	

9

Northing (ft):	225507.527
Easting (ft):	1750889.288
Elevation (ft):	1140.866

Detailed Description:

NE corner of concrete driveway at house at end of CR 52/4



### GNSS CONTROL POINT LOCATION SHEET

Horizontal Datum: NAD83	Vertical Datum: NAVD88
Projection: WV North (4701)	Geoid: Geoid12B
Precisions (ft): H: 0.013 V: 0.035 Post Processed	Method: Static
Date: 3/21/2019	Operator: Lynch
Location: Metz, Marion County, WV	

**M-1**

Northing (ft): 407702.538

Easting (ft): 1710111.567

Elevation (ft): 1060.974

Detailed Description:

SE corner of drain in driveway along Rt. 250/3



### GNSS CONTROL POINT LOCATION SHEET

Horizontal Datum: NAD83	Vertical Datum: NAVD88
Projection: WV North (4701)	Geoid: Geoid12B
Precisions (ft): H: 0.103ft V: 0.119ft @95%Conf Method: VRS	
Date: 3/21/2019	Operator: Lynch
Location: Rivesville, Marion County, WV	

**M-2**

Northing (ft): 386692.534

Easting (ft): 1795940.469

Elevation (ft): 1123.612

Detailed Description:

Corner of concrete drive along William Smith Road



### GNSS CONTROL POINT LOCATION SHEET

Horizontal Datum: NAD83	Vertical Datum: NAVD88
Projection: WV North (4701)	Geoid: Geoid12B
Precisions (ft): H: 0.087 V: 0.099 @95%Conf	Method: VRS
Date: 3/21/2019	Operator: Lynch
Location: Mannington, Marion County, WV	

**M-3**

Northing (ft): 376425.880  
 Easting (ft): 1731345.753  
 Elevation (ft): 972.203

Detailed Description:

Intersection of yellow parking lines in Manning PSD parking a lot



### GNSS CONTROL POINT LOCATION SHEET

Horizontal Datum: NAD83	Vertical Datum: NAVD88
Projection: WV North (4701)	Geoid: Geoid12B
Precisions (ft): H: 0.071 V: 0.112 @95%Conf	Method: VRS
Date: 3/21/2019	Operator: Lynch
Location: Fairmont, Marion County, WV	

M-4

Northing (ft):	353928.694
Easting (ft):	1783648.365
Elevation (ft):	1042.666

**Detailed Description:**

NW corner of sidewalk at intersection of Beverly Road and 12th Street



### GNSS CONTROL POINT LOCATION SHEET

Horizontal Datum: NAD83	Vertical Datum: NAVD88
Projection: WV North (4701)	Geoid: Geoid12B
Precisions (ft): H: 0.050 V: 0.078 @95%Conf	Method: VRS
Date: 3/21/2019	Operator: Lynch
Location: Fairmont, Marion County, WV	

**M-5**

Detailed Description:

SE corner of driveway at home at 305 Ben Bryan Blvd

Northing (ft): 344637.367

Easting (ft): 1842268.475

Elevation (ft): 1774.818



### GNSS CONTROL POINT LOCATION SHEET

Horizontal Datum: NAD83	Vertical Datum: NAVD88
Projection: WV North (4701)	Geoid: Geoid12B
Precisions (ft): H: 0.043 V: 0.060 @95%Conf	Method: VRS
Date: 3/21/2019	Operator: Lynch
Location: Pruntytown, Taylor County, WV	

**T-1**

Northing (ft): 303862.414

Easting (ft): 1807124.697

Elevation (ft): 1309.748

Detailed Description:

NW corner of drop inlet along  
Veterans Memorial Drive



### GNSS CONTROL POINT LOCATION SHEET

Horizontal Datum: NAD83	Vertical Datum: NAVD88
Projection: WV North (4701)	Geoid: Geoid12B
Precisions (ft): H: 0.067 V: 0.079 @95%Conf	Method: VRS
Date: 3/21/2019	Operator: Lynch
Location: Evansville, Taylor County, WV	

**T-2**

Northing (ft): 304249.993

Easting (ft): 1855599.531

Elevation (ft): 1322.543

Detailed Description:

NE corner of garage concrete pad at 3691 George Washington Highway

