

THRASHER

2023 Counties
Berkeley and Jefferson
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 March 15 and March 16, 2023.

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 34 flight lines. The designed ground sample distance per pixel was 10 centimeters.

The block consisted of a total of 1,651 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 an Ultracam Eagle 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.

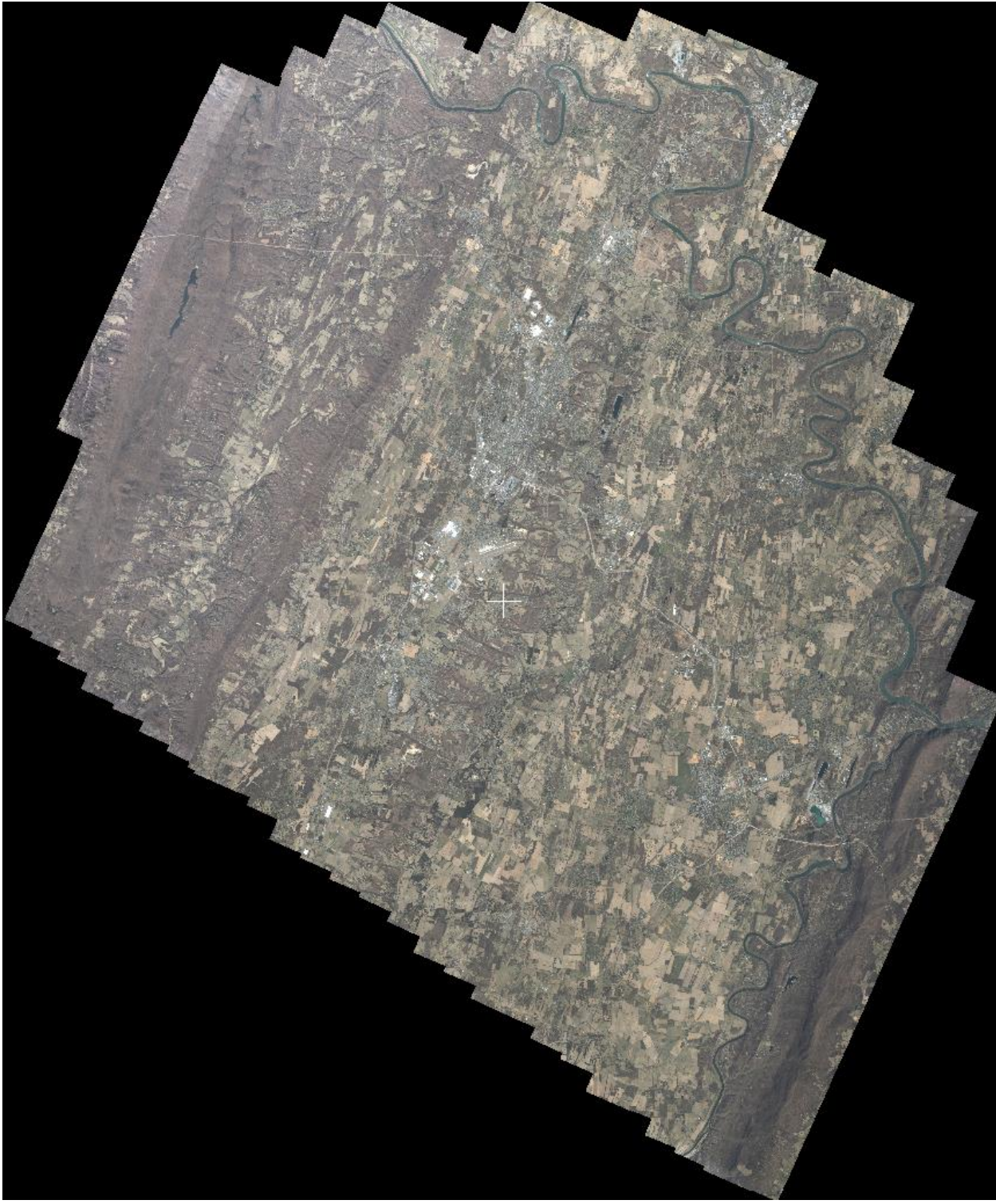
Internal software checks were performed to detect gross errors in the photo measurements.

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

Point Name	Bundle Coord Residuals		
	Delta X	Delta Y	Delta Z
28593	0.175	-0.096	-0.071
28594	0.018	-0.112	-0.027
28592	-0.023	-0.119	0.003
28603	0.047	0.115	-0.013
28595	-0.052	-0.059	-0.109
28601	0.078	0.020	-0.010
28602	-0.030	-0.019	-0.072
28598	-0.023	0.088	-0.052
28596	-0.135	-0.060	-0.174
28597	-0.030	0.045	0.016
28605	-0.067	0.030	-0.145
28608	-0.010	-0.000	0.045
28607	-0.005	-0.015	0.014
28606	0.001	0.004	0.052
28611	-0.001	0.002	0.019
28614	-0.000	-0.002	0.001



GNSS CONTROL POINT LOCATION SHEET

Adam Riggleman
 Created Mon, 28 Feb 2022, 10:29 AM (UTC-05)

Date Mon, 28 Feb 2022

Project Name 40-10505

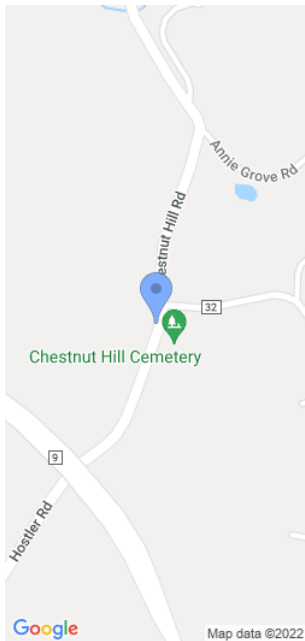
Project Location Harpers Ferry, WV

Horizontal Datum	Wv North Nad 83	Vertical Datum	NAVD 88	Geoid	18
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Point Name	Method	Description	Northing(ft)	Easting (Ft)	Elevation (ft)	Photograph
28059001	WV VRS	Corner Concrete	285721.424	2458767.195	572.106	 See full page photos attached at end of PDF

Signature -

Signature -



Captured by: Adam Riggleman

Captured on: Mon, 28 Feb 2022, 10:29 am

Tags:

Description:

Comments:



GNSS CONTROL POINT LOCATION SHEET

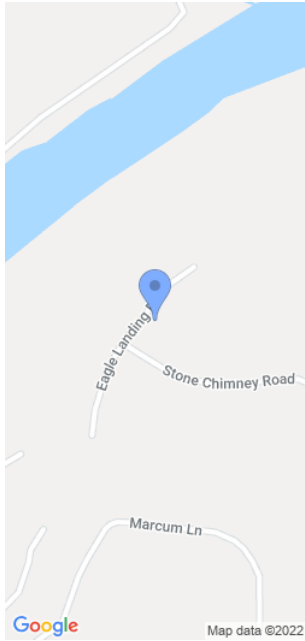
Adam Riggleman
 Created Mon, 28 Feb 2022, 11:39 AM (UTC-05)

Date	Mon, 28 Feb 2022
Project Name	40-10505
Project Location	Riverside, WV

Horizontal Datum	Wv North Nad 83	Vertical Datum	NAVD 88	Geoid	18
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Point Name	Method	Description	Northing(ft)	Easting (Ft)	Elevation (ft)	Photograph
28059002	WV VRS	Corner Concrete	251772.444	2434933.326	476.246	 <p>See full page photos attached at end of PDF</p>

Signature	-
Signature	-



Captured by: Adam Riggleman

Captured on: Mon, 28 Feb 2022, 11:40 am

Tags:

Description:

Comments:



GNSS CONTROL POINT LOCATION SHEET

Adam Riggleman
 Created Mon, 28 Feb 2022, 12:24 PM (UTC-05)

Date Mon, 28 Feb 2022

Project Name 40-10505

Project Location Franklinton, WV

Horizontal Datum	Wv North Nad 83	Vertical Datum	NAVD 88	Geoid	18
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Point Name	Method	Description	Northing(ft)	Easting (Ft)	Elevation (ft)	Photograph
28059003	WV VRS	Fence Post	258046.941	2416735.134	537.678	 See full page photos attached at end of PDF

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Captured by: Adam Riggleman

Captured on: Mon, 28 Feb 2022, 12:24 pm

Tags:

Description:

Comments:



GNSS CONTROL POINT LOCATION SHEET

Adam Riggleman
 Created Mon, 28 Feb 2022, 1:36 PM (UTC-05)

Date	Mon, 28 Feb 2022
Project Name	40-10505
Project Location	Charles Town, WV

Horizontal Datum	Wv North Nad 83	Vertical Datum	NAVD 88	Geoid	18
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Point Name	Method	Description	Northing(ft)	Easting (Ft)	Elevation (ft)	Photograph
28059004	WV VRS	Corner Concrete	297359.785	2431128.681	536.132	 See full page photos attached at end of PDF

Signature	-
Signature	-



Captured by: Adam Riggleman

Captured on: Mon, 28 Feb 2022, 1:37 pm

Tags:

Description:

Comments:



Feb 28, 2022
1:37 PM UTC -05:00
The Thrasher Group
Survey

GNSS CONTROL POINT LOCATION SHEET


Adam Riggleman
 Created Mon, 28 Feb 2022, 2:56 PM (UTC-05)

Date Mon, 28 Feb 2022

Project Name 40-10505

Project Location Harpers Ferry, WV

Horizontal Datum	Wv North Nad 83	Vertical Datum	NAVD 88	Geoid	18
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Point Name	Method	Description	Northing(ft)	Easting (Ft)	Elevation (ft)	Photograph
28059005	WV VRS	Corner Concrete	305193.035	2468750.868	288.211	 See full page photos attached at end of PDF

Signature -

Signature -



Captured by: Adam Riggleman
Captured on: Mon, 28 Feb 2022, 2:58 pm
Tags:
Description:
Comments:



Feb 28, 2022
2:58 PM UTC -05:00
The Thrasher Group
Survey

GNSS CONTROL POINT LOCATION SHEET

Adam Riggleman
 Created Mon, 28 Feb 2022, 4:01 PM (UTC-05)

Date Mon, 28 Feb 2022

Project Name 40-10505

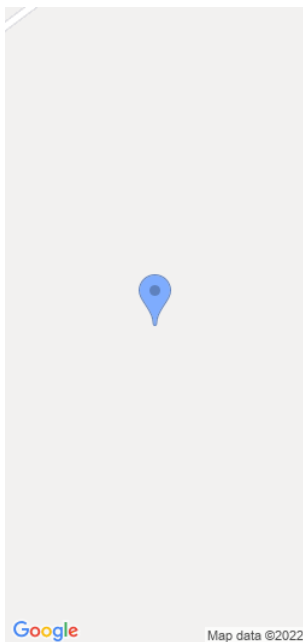
Project Location Shepardstown, WV

Horizontal Datum	Wv North Nad 83	Vertical Datum	NAVD 88	Geoid	18
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Point Name	Method	Description	Northing(ft)	Easting (Ft)	Elevation (ft)	Photograph
28059006	WV VRS	Corner Concrete	335194.619	2460629.025	451.843	 See full page photos attached at end of PDF

Signature -

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Captured by: Adam Riggleman

Captured on: Mon, 28 Feb 2022, 4:02 pm

Tags:

Description:

Comments:



GNSS CONTROL POINT LOCATION SHEET


Adam Riggleman
 Created Mon, 28 Feb 2022, 4:46 PM (UTC-05)

Date Mon, 28 Feb 2022

Project Name 40-10505

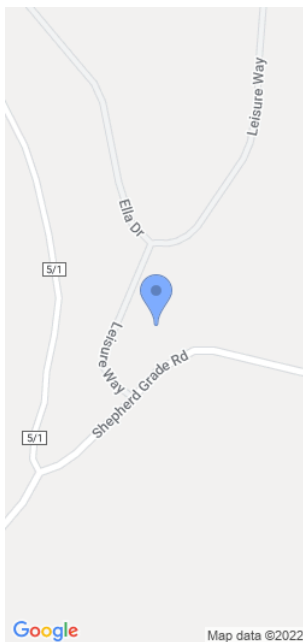
Project Location Jefferson County, WV

Horizontal Datum	Wv North Nad 83	Vertical Datum	NAVD 88	Geoid	18
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Point Name	Method	Description	Northing(ft)	Easting (Ft)	Elevation (ft)	Photograph
28059007	WV VRS	Corner Concrete	362318.604	2442084.246	433.311	 <p>See full page photos attached at end of PDF</p>

Signature -

Signature -



Captured by: Adam Riggleman

Captured on: Mon, 28 Feb 2022, 4:47 pm

Tags:

Description:

Comments:



Feb 28, 2022
4:47 PM UTC -05:00
The Thrasher Group
Survey

GNSS CONTROL POINT LOCATION SHEET


Adam Riggleman
 Created Mon, 28 Feb 2022, 5:46 PM (UTC-05)

Date Mon, 28 Feb 2022

Project Name 40-10505

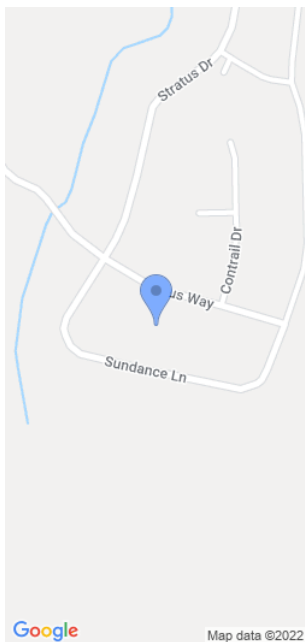
Project Location Kearnyville, WV

Horizontal Datum	Wv North Nad 83	Vertical Datum	NAVD 88	Geoid	18
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Point Name	Method	Description	Northing(ft)	Easting (Ft)	Elevation (ft)	Photograph
28059008	WV VRS	Corner Concrete	326634.283	2415799.002	483.03	 See full page photos attached at end of PDF

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Captured by: Adam Riggleman
Captured on: Mon, 28 Feb 2022, 5:47 pm
Tags:
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Feb 28, 2022
5:47 PM UTC -05:00
The Thrasher Group
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GNSS CONTROL POINT LOCATION SHEET

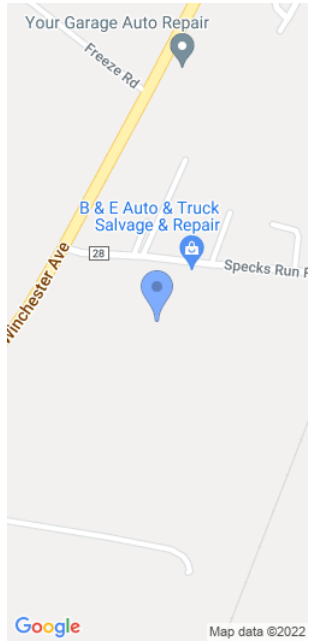
Adam Riggleman
 Created Tue, 01 Mar 2022, 8:16 AM (UTC-05)

Date	Tue, 01 Mar 2022
Project Name	40-10505
Project Location	Russel Spring, WV

Horizontal Datum	Wv North Nad 83	Vertical Datum	NAVD 88	Geoid	18
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Point Name	Method	Description	Northing(ft)	Easting (Ft)	Elevation (ft)	Photograph
28060001	WV VRS	Corner Concrete	286731.797	2388530.049	550.666	 See full page photos attached at end of PDF

Signature	-
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Captured by: Adam Riggleman
Captured on: Tue, 01 Mar 2022, 8:17 am
Tags:
Description:
Comments:




GNSS CONTROL POINT LOCATION SHEET

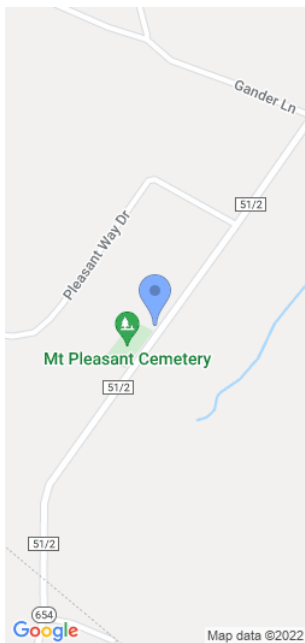
Adam Riggleman
 Created Tue, 01 Mar 2022, 9:07 AM (UTC-05)

Date	Tue, 01 Mar 2022
Project Name	40-10505
Project Location	Mt. Pleasant united baptist

Horizontal Datum	Wv North Nad 83	Vertical Datum	NAVD 88	Geoid	18
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Point Name	Method	Description	Northing(ft)	Easting (Ft)	Elevation (ft)	Photograph
28060002	WV VRS	Corner Concrete	306698.798	2354865.615	762.871	 <p>See full page photos attached at end of PDF</p>

Signature	-
Signature	-



Captured by: Adam Riggleman
Captured on: Tue, 01 Mar 2022, 9:09 am
Tags:
Description:
Comments:



Mar 1, 2022
9:09 AM UTC -05:00
The Thrasher Group
Survey

GNSS CONTROL POINT LOCATION SHEET

Adam Riggleman
 Created Tue, 01 Mar 2022, 10:03 AM (UTC-05)

Date Tue, 01 Mar 2022

Project Name 40-10505

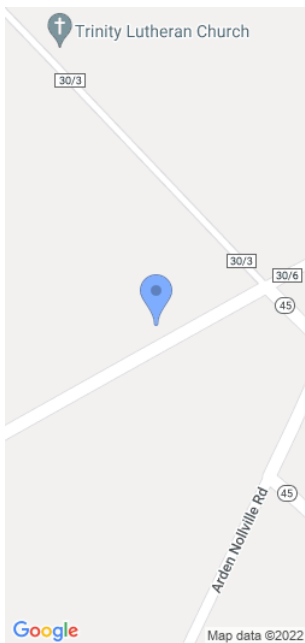
Project Location Arden, WV

Horizontal Datum	Wv North Nad 83	Vertical Datum	NAVD 88	Geoid	18
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Point Name	Method	Description	Northing(ft)	Easting (Ft)	Elevation (ft)	Photograph
28060003	WV VRS	Corner concrete	338248.15	2380068.386	679.361	 <p>See full page photos attached at end of PDF</p>

Signature -

Signature -



Captured by: Adam Riggleman

Captured on: Tue, 01 Mar 2022, 10:03 am

Tags:

Description:

Comments:



GNSS CONTROL POINT LOCATION SHEET

Adam Riggleman
 Created Tue, 01 Mar 2022, 11:22 AM (UTC-05)

Date	Tue, 01 Mar 2022
Project Name	40-10505
Project Location	Martinsburg, WV

Horizontal Datum	Wv North Nad 83	Vertical Datum	NAVD 88	Geoid	18
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Point Name	Method	Description	Northing(ft)	Easting (Ft)	Elevation (ft)	Photograph
28060004	WV VRS	Corner Concrete	366932.47	2404650.689	474.258	 <p>See full page photos attached at end of PDF</p>

Signature	-
Signature	-



Captured by: Adam Riggleman

Captured on: Tue, 01 Mar 2022, 11:23 am

Tags:

Description:

Comments:



Mar 1, 2022
11:23 AM UTC -05:00
The Thrasher Group
Survey

GNSS CONTROL POINT LOCATION SHEET

Adam Riggleman
 Created Tue, 01 Mar 2022, 12:03 PM (UTC-05)

Date Tue, 01 Mar 2022

Project Name 40-10505

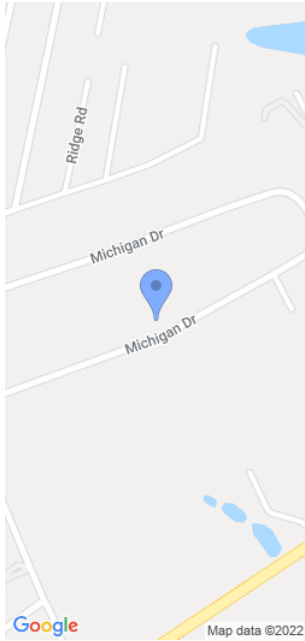
Project Location Berkeley County, WV

Horizontal Datum	Wv North Nad 83	Vertical Datum	NAVD 88	Geoid	18
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Point Name	Method	Description	Northing(ft)	Easting (Ft)	Elevation (ft)	Photograph
28060005	WV VRS	Corner Concrete	403897.286	2433341.998	538.414	 See full page photos attached at end of PDF

Signature -

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Captured by: Adam Riggleman

Captured on: Tue, 01 Mar 2022, 12:04 pm

Tags:

Description:

Comments:



Mar 1, 2022
12:04 PM UTC -05:00
The Thrasher Group
Survey

GNSS CONTROL POINT LOCATION SHEET


Adam Riggleman
 Created Tue, 01 Mar 2022, 4:16 PM (UTC-05)


Date Tue, 01 Mar 2022

Project Name 40-10505

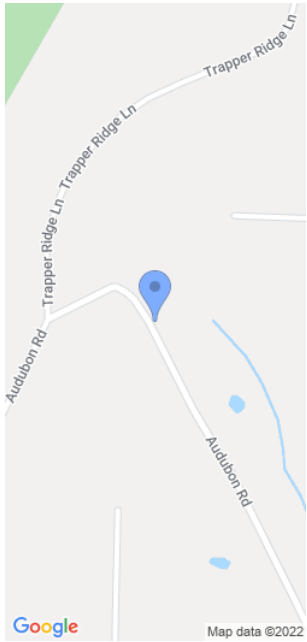
Project Location Hedgesville, WV

Horizontal Datum	Wv North Nad 83	Vertical Datum	NAVD 88	Geoid	18
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Point Name	Method	Description	Northing(ft)	Easting (Ft)	Elevation (ft)	Photograph
28060006	RTK & infill	Utility Pole	400975.122	2358650.761	1073.037	 See full page photos attached at end of PDF

Signature  james Howes, Mon, 07 Mar 2022, 9:09 am

Signature -



Captured by: Adam Riggleman
Captured on: Tue, 01 Mar 2022, 4:17 pm
Tags:
Description:
Comments:



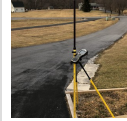
Mar 1, 2022
4:17 PM UTC -05:00
The Thrasher Group
Survey

GNSS CONTROL POINT LOCATION SHEET

Adam Riggleman
 Created Tue, 01 Mar 2022, 4:47 PM (UTC-05)

Date	Tue, 01 Mar 2022
Project Name	40-10505
Project Location	Tomahawk, WV

Horizontal Datum	Wv North Nad 83	Vertical Datum	NAVD 88	Geoid	18
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Point Name	Method	Description	Northing(ft)	Easting (Ft)	Elevation (ft)	Photograph
28060007	WV VRS	Corner Concrete	375938.556	2373267.857	609.014	 <p>See full page photos attached at end of PDF</p>

Signature	-
Signature	-



Captured by: Adam Riggleman

Captured on: Tue, 01 Mar 2022, 4:48 pm

Tags:

Description:

Comments:




GNSS CONTROL POINT LOCATION SHEET

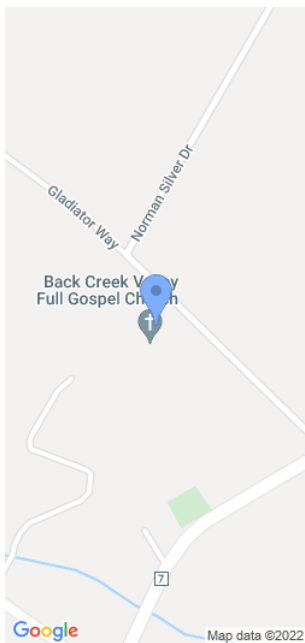
Adam Riggleman
 Created Tue, 01 Mar 2022, 5:09 PM (UTC-05)

Date	Tue, 01 Mar 2022
Project Name	40-10505
Project Location	Shanghai, WV

Horizontal Datum	Wv North Nad 83	Vertical Datum	NAVD 88	Geoid	18
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Point Name	Method	Description	Northing(ft)	Easting (Ft)	Elevation (ft)	Photograph
28060008	WV VRS	Corner Concrete	347680.053	2354953.449	592.637	 See full page photos attached at end of PDF

Signature	-
Signature	-



Captured by: Adam Riggleman
Captured on: Tue, 01 Mar 2022, 5:10 pm
Tags:
Description:
Comments:




GNSS CONTROL POINT LOCATION SHEET

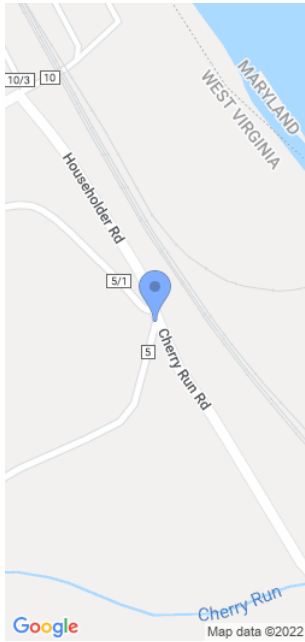
Adam Riggleman
 Created Wed, 02 Mar 2022, 8:46 AM (UTC-05)

Date	Wed, 02 Mar 2022
Project Name	40-10505
Project Location	Cherry Run, WV

Horizontal Datum	Wv North Nad 83	Vertical Datum	NAVD 88	Geoid	18
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Point Name	Method	Description	Northing(ft)	Easting (Ft)	Elevation (ft)	Photograph
28061001	WV VRS	Corner Concrete	412876.539	2382186.435	436.129	 <p>See full page photos attached at end of PDF</p>

Signature	-
Signature	-



Captured by: Adam Riggleman
Captured on: Wed, 02 Mar 2022, 8:47 am
Tags:
Description:
Comments:




GNSS CONTROL POINT LOCATION SHEET

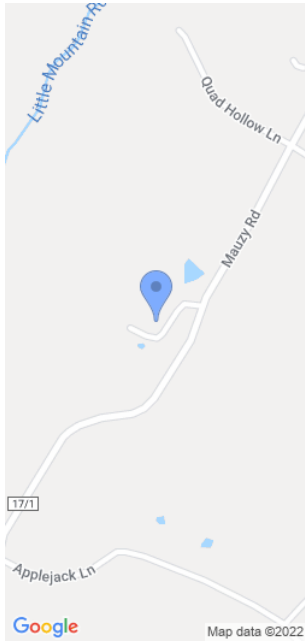
Adam Riggleman
 Created Wed, 02 Mar 2022, 12:08 PM (UTC-05)

Date	Wed, 02 Mar 2022
Project Name	40-10505
Project Location	Morgan County, WV

Horizontal Datum	Wv North Nad 83	Vertical Datum	NAVD 88	Geoid	18
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Point Name	Method	Description	Northing(ft)	Easting (Ft)	Elevation (ft)	Photograph
28061004	WV VRS	Corner Concrete	333193.873	2324971.3	1062.331	 <p>See full page photos attached at end of PDF</p>

Signature	-
Signature	-



Captured by: Adam Riggleman

Captured on: Wed, 02 Mar 2022, 12:09 pm

Tags:

Description:

Comments:

