

THRASHER

2023 Cabell County Aerial Triangulation And Ground Control Report

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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 5, 2023 and March 6, 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 5,000 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 38 flight lines. The designed ground sample distance per pixel was 3 inches.

The block consisted of a total of 1,931 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.

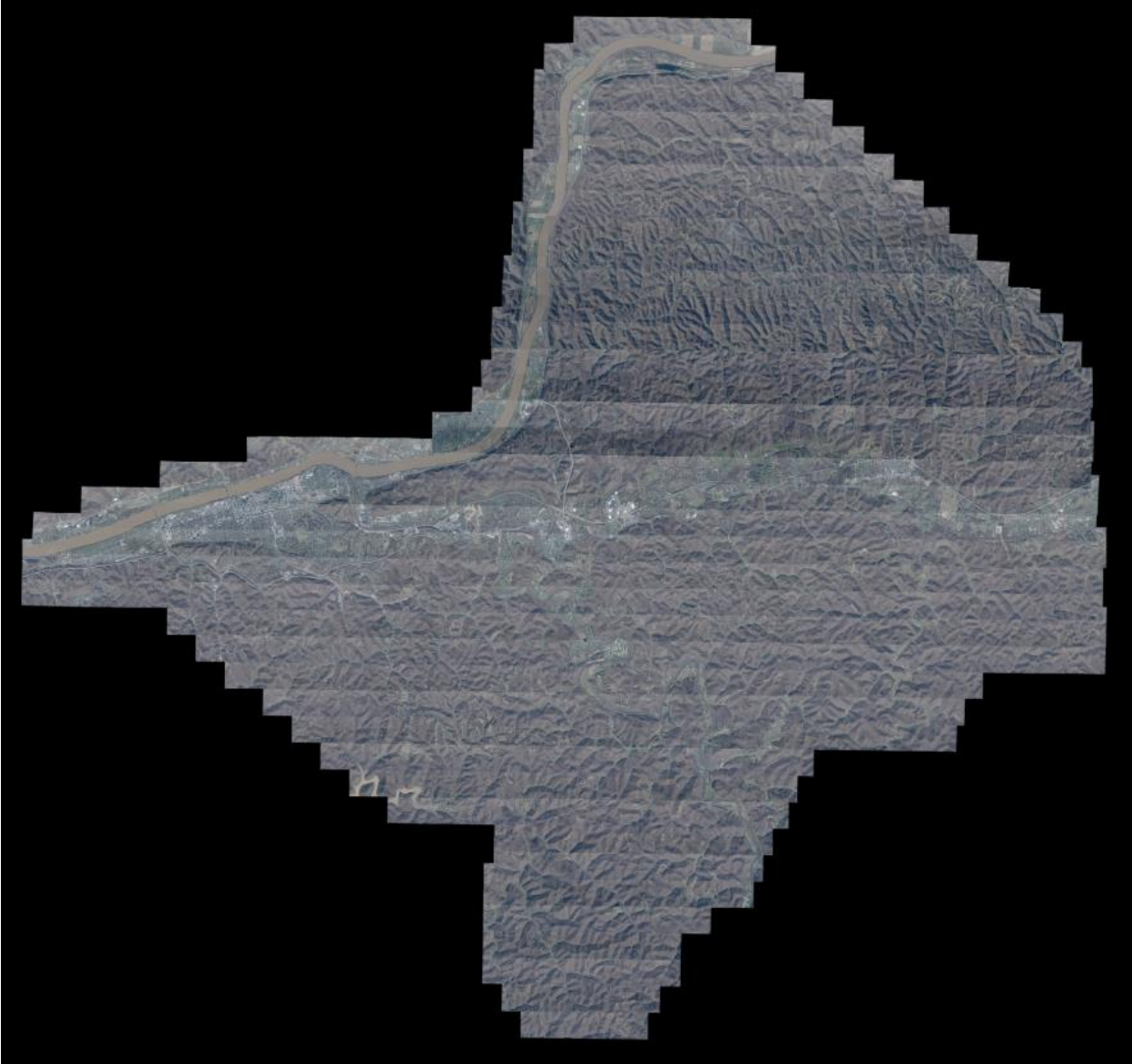
Bundle Adjustment

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.

Twenty control points were used to constrain the AT solution. The residuals of the control points from measured position to surveyed position are as follows:

Residual point x y z (ft.)

6	-0.143	-0.046	-0.223
17	-0.077	-0.063	-0.239
7	0.036	-0.021	-0.202
9	0.014	-0.034	-0.209
19	-0.078	-0.058	-0.197
13	0.010	0.075	-0.253
4	-0.032	0.005	-0.164
5	-0.059	-0.037	-0.211
10	-0.009	0.089	-0.189
11	-0.015	-0.028	-0.131
14	-0.023	0.058	-0.082
15	-0.010	0.051	-0.198
3A	-0.004	0.006	-0.110
16	0.034	-0.008	-0.146
2	-0.030	-0.021	-0.168
18	-0.036	0.013	-0.093
20	0.008	0.019	-0.100
1	0.004	0.011	-0.092
8	0.012	-0.005	-0.018
12	-0.000	0.001	-0.000



GNSS CONTROL POINT LOCATION SHEET

Horizontal Datum: NAD83	Vertical Datum: NAVD88
Projection: WV South (4702)	Geoid: Geoid12B
Precisions (ft): H: 0.05 V: 0.06 @95%Conf	Method: VRS
Date: 2/21/2019	Operator: Brown
Location: CABELL - WAYNE COUNTY, WV - Westmoreland	

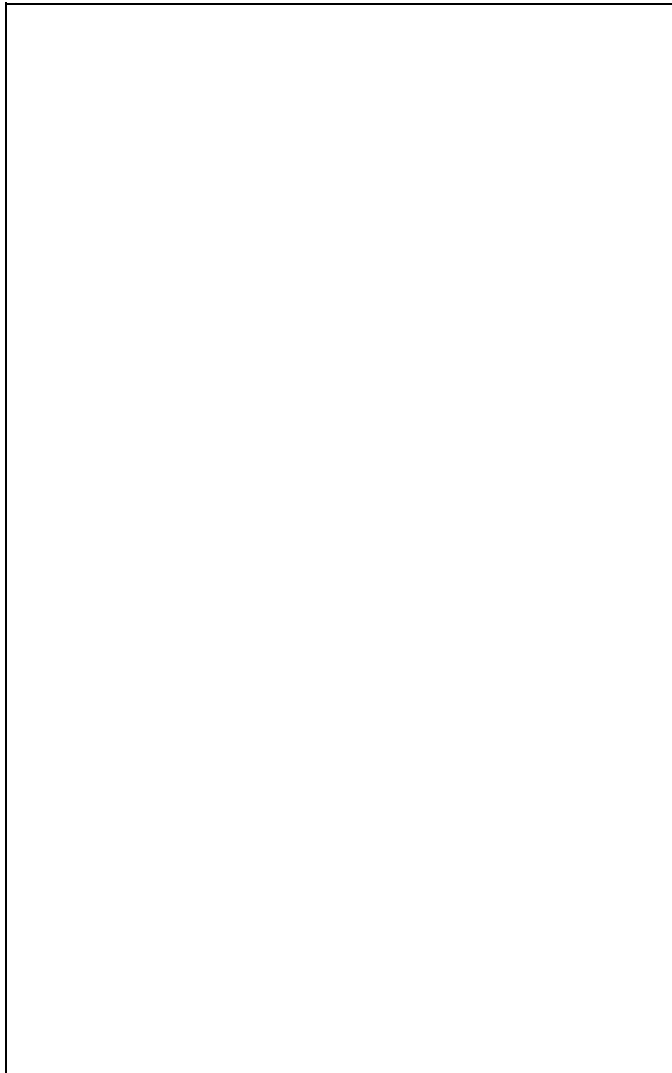
1

Northing (ft):	512548.14
Easting (ft):	1531384.98
Elevation (ft):	550.55



Detailed Description:

Corner concrete pad for water meter



GNSS CONTROL POINT LOCATION SHEET

Horizontal Datum: NAD83	Vertical Datum: NAVD88
Projection: WV South (4702)	Geoid: Geoid12B
Precisions (ft): H: 0.06 V: 0.08 @95% Conf	Method: VRS
Date: 2/21/2019	Operator: Brown
Location: CABELL COUNTY, WV - Culloden	

2

Northing (ft):	518844.00
Easting (ft):	1666797.10
Elevation (ft):	701.12

Detailed Description:

Corner concrete pad



GNSS CONTROL POINT LOCATION SHEET

Horizontal Datum: NAD83	Vertical Datum: NAVD88
Projection: WV South (4702)	Geoid: Geoid12B
Accuracies (ft): N: 0.05 E: 0.03 V: 0.07	Method: Static (OPUS)
Date: 2/21/2019	Operator: Freshour
Location: CABELL COUNTY, WV - Raccoon Creek	

3

Detailed Description:

Corner concrete pad

Northing (ft):	456001.71
Easting (ft):	1599945.97
Elevation (ft):	690.54



GNSS CONTROL POINT LOCATION SHEET

Horizontal Datum: NAD83	Vertical Datum: NAVD88
Projection: WV South (4702)	Geoid: Geoid12B
Precisions (ft): H: 0.03 V: 0.07 @95% Conf	Method: VRS
Date: 2/21/2019	Operator: Brown
Location: CABELL COUNTY, WV - Barboursville	

4

Northing (ft):	517936.09
Easting (ft):	1607688.13
Elevation (ft):	563.09

Detailed Description:

Corner concrete pad



GNSS CONTROL POINT LOCATION SHEET

Horizontal Datum: NAD83	Vertical Datum: NAVD88
Projection: WV South (4702)	Geoid: Geoid12B
Precisions (ft): H: 0.10 V: 0.08 @95% Conf	Method: VRS
Date: 2/21/2019	Operator: Brown
Location: CABELL COUNTY, WV - Huntington	

5

Northing (ft):	519118.69
Easting (ft):	1558711.66
Elevation (ft):	564.43

Detailed Description:

Corner concrete pad



GNSS CONTROL POINT LOCATION SHEET

Horizontal Datum: NAD83	Vertical Datum: NAVD88
Projection: WV South (4702)	Geoid: Geoid12B
Precisions (ft): H: 0.04 V: 0.07 @95% Conf	Method: VRS
Date: 2/21/2019	Operator: Brown
Location: CABELL COUNTY, WV - Pea Ridge	

6

Northing (ft):	518334.16
Easting (ft):	1584166.66
Elevation (ft):	566.27

Detailed Description:

Corner concrete parking lot



GNSS CONTROL POINT LOCATION SHEET

Horizontal Datum: NAD83	Vertical Datum: NAVD88
Projection: WV South (4702)	Geoid: Geoid12B
Precisions (ft): H: 0.09 V: 0.11 @95% Conf	Method: VRS
Date: 2/21/2019	Operator: Brown
Location: CABELL COUNTY, WV - Milton	

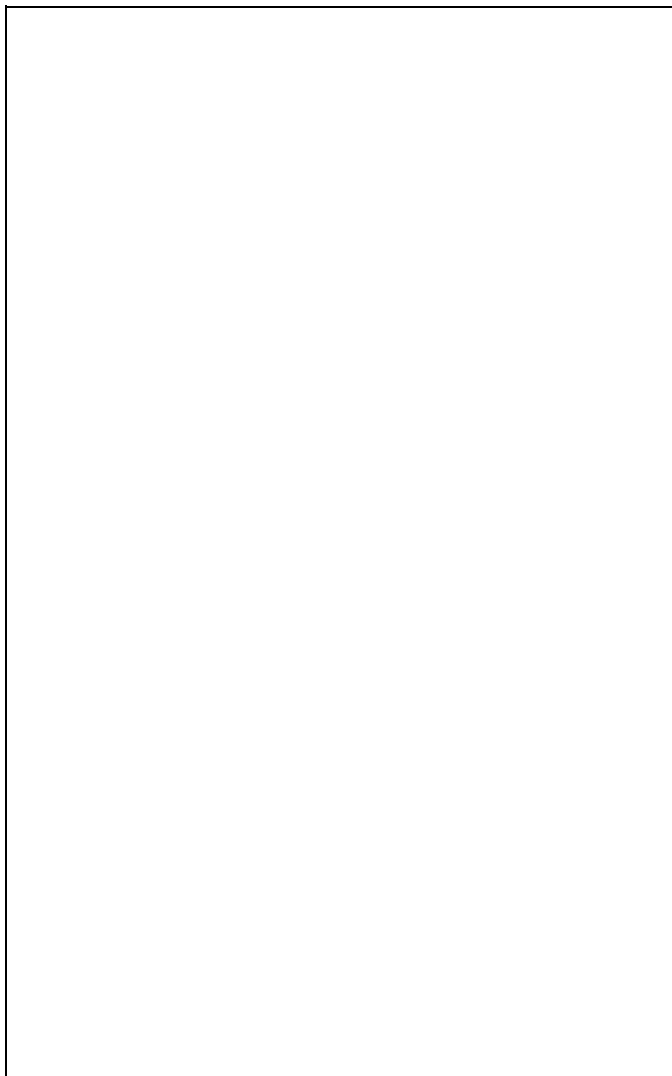
7

Northing (ft):	531966.16
Easting (ft):	1649604.70
Elevation (ft):	656.32



Detailed Description:

Corner concrete pad



GNSS CONTROL POINT LOCATION SHEET

Horizontal Datum: NAD83	Vertical Datum: NAVD88
Projection: WV South (4702)	Geoid: Geoid12B
Precisions (ft): H: 0.04 V: 0.05 @95% Conf	Method: VRS
Date: 2/21/2019	Operator: Freshour
Location: CABELL COUNTY, WV - Ona	

8

Northing (ft):	528531.71
Easting (ft):	1627905.93
Elevation (ft):	579.50

Detailed Description:

Edge concrete pad @ construction joint



GNSS CONTROL POINT LOCATION SHEET

Horizontal Datum: NAD83	Vertical Datum: NAVD88
Projection: WV South (4702)	Geoid: Geoid12B
Precisions (ft): H: 0.08 V: 0.09 @95% Conf	Method: VRS
Date: 2/21/2019	Operator: Freshour
Location: CABELL COUNTY, WV - Salt Rock	

9

Northing (ft):	484087.37
Easting (ft):	1618392.90
Elevation (ft):	581.14

Detailed Description:

Concrete pad @ construction joint



GNSS CONTROL POINT LOCATION SHEET

Horizontal Datum: NAD83	Vertical Datum: NAVD88
Projection: WV South (4702)	Geoid: Geoid12B
Precisions (ft): H: 0.05 V: 0.08 @95% Conf	Method: VRS
Date: 2/21/2019	Operator: Freshour
Location: CABELL COUNTY, WV - Salt Rock	

10

Northing (ft):	477864.04
Easting (ft):	1610000.52
Elevation (ft):	674.72

Detailed Description:

Corner concrete pad



GNSS CONTROL POINT LOCATION SHEET

Horizontal Datum: NAD83	Vertical Datum: NAVD88
Projection: WV South (4702)	Geoid: Geoid12B
Accuracies (ft): N: 0.01 E: 0.01 V: 0.03	Method: Static (OPUS)
Date: 2/21/2019	Operator: Freshour
Location: CABELL COUNTY, WV - Ona	

11

Northing (ft):	509262.81
Easting (ft):	1632301.04
Elevation (ft):	680.33

Detailed Description:

Edge concrete drive @ construction joint



GNSS CONTROL POINT LOCATION SHEET

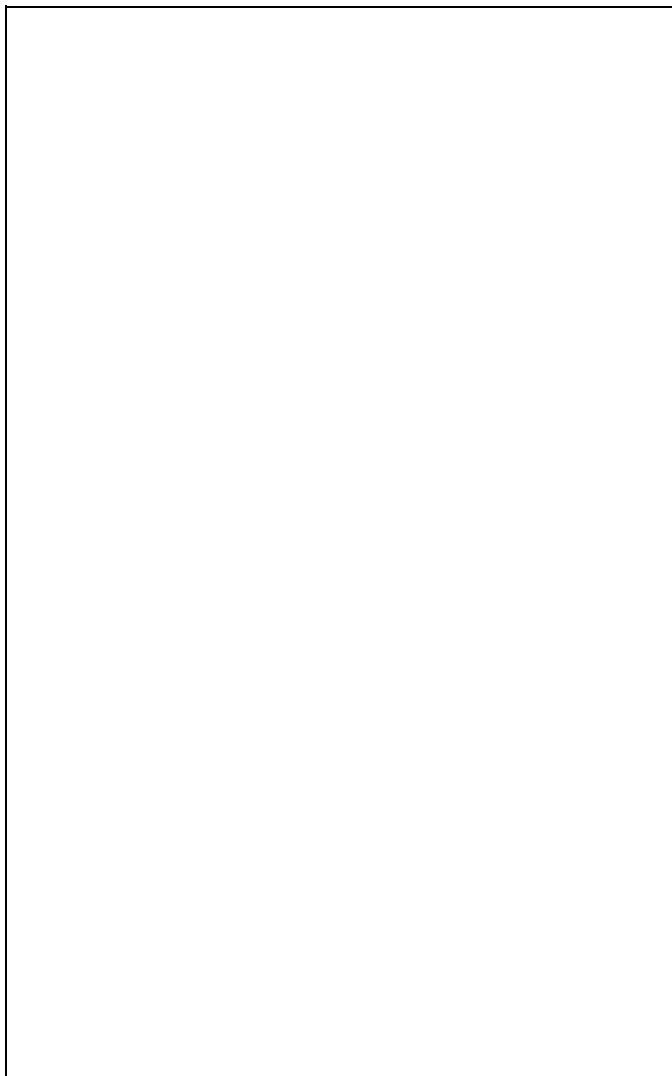
Horizontal Datum: NAD83	Vertical Datum: NAVD88
Projection: WV South (4702)	Geoid: Geoid12B
Precision (ft): H: 0.08 V: 0.12 @95% Conf	Method: VRS
Date: 2/21/2019	Operator: Brown
Location: CABELL COUNTY, WV - Barboursville	

12

Northing (ft):	500813.89
Easting (ft):	1602963.43
Elevation (ft):	569.65

Detailed Description:

Edge concrete drive @ angle point



GNSS CONTROL POINT LOCATION SHEET

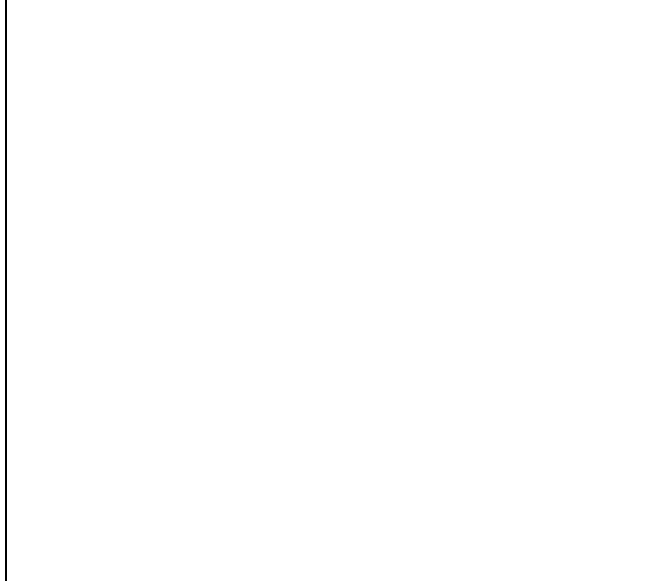
Horizontal Datum: NAD83	Vertical Datum: NAVD88
Projection: WV South (4702)	Geoid: Geoid12B
Precisions (ft): H: 0.02 V: 0.05 @ 95% Conf	Method: VRS
Date: 2/21/2019	Operator: Freshour
Location: CABELL COUNTY, WV	

13

Northing (ft):	490331.57
Easting (ft):	1584186.90
Elevation (ft):	672.63

Detailed Description:

Corner concrete bridge apron



GNSS CONTROL POINT LOCATION SHEET

Horizontal Datum: NAD83	Vertical Datum: NAVD88
Projection: WV South (4702)	Geoid: Geoid12B
Precisions (ft): H: 0.05 V: 0.12 @95% Conf	Method: VRS
Date: 2/21/2019	Operator: Freshour
Location: CABELL COUNTY, WV - Mt Union	

14

Northing (ft):	500126.54
Easting (ft):	1561261.95
Elevation (ft):	868.01

Detailed Description:

Inside corner concrete walk



GNSS CONTROL POINT LOCATION SHEET

Horizontal Datum: NAD83	Vertical Datum: NAVD88
Projection: WV South (4702)	Geoid: Geoid12B
Precisions (ft): H: 0.06 V: 0.07 @95% Conf	Method: VRS
Date: 2/21/2019	Operator: Brown
Location: CABELL COUNTY, WV	

15

Northing (ft):	498143.75
Easting (ft):	1644456.79
Elevation (ft):	610.78

Detailed Description:

Corner concrete MH Skirt



GNSS CONTROL POINT LOCATION SHEET

Horizontal Datum: NAD83	Vertical Datum: NAVD88
Projection: WV South (4702)	Geoid: Geoid12B
Precisions (ft): H: 0.10 V: 0.14 @95% Conf	Method: VRS
Date: 2/21/2019	Operator: Freshour
Location: CABELL COUNTY, WV	

16

Northing (ft):	573833.94
Easting (ft):	1601822.26
Elevation (ft):	583.67

Detailed Description:

Intersection concrete construction joints



GNSS CONTROL POINT LOCATION SHEET

Horizontal Datum: NAD83	Vertical Datum: NAVD88
Projection: WV South (4702)	Geoid: Geoid12B
Precisions (ft): H: 0.04 V: 0.05 @95% Conf	Method: VRS
Date: 2/21/2019	Operator: Freshour
Location: CABELL COUNTY, WV - Glenwood	

17

Northing (ft):	579074.03
Easting (ft):	1617590.67
Elevation (ft):	559.30

Detailed Description:

Inside lower corner painted RR Xing striping



GNSS CONTROL POINT LOCATION SHEET

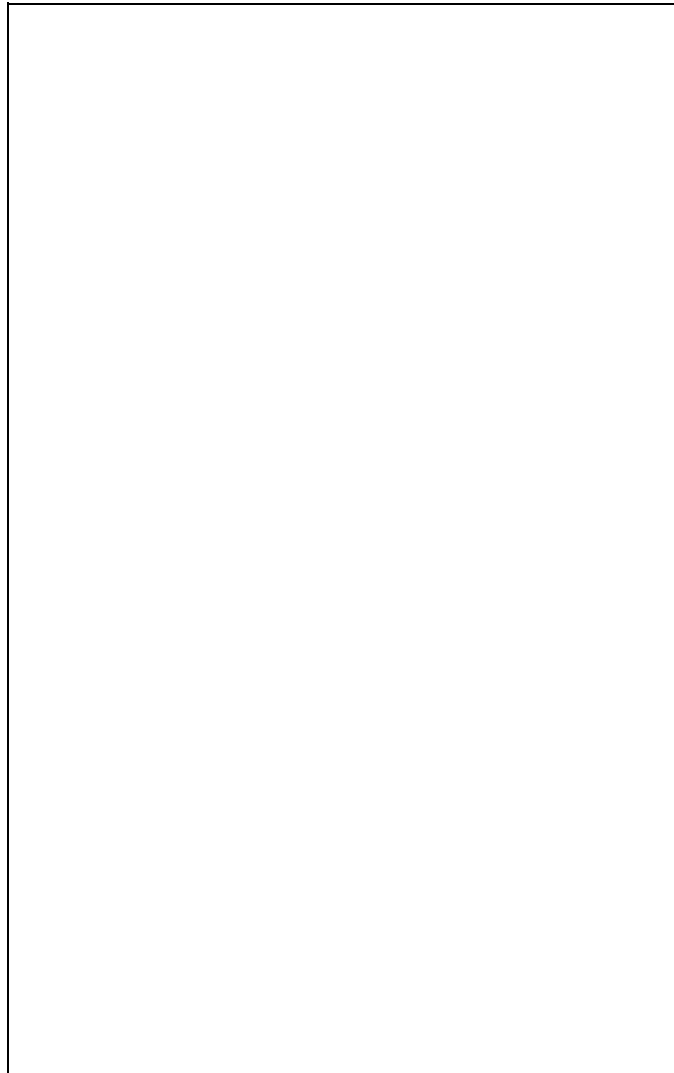
Horizontal Datum: NAD83	Vertical Datum: NAVD88
Projection: WV South (4702)	Geoid: Geoid12B
Precisions (ft): H: 0.06 V: 0.09 @95% Conf	Method: VRS
Date: 2/21/2019	Operator: Brown
Location: CABELL COUNTY, WV	

18

Northing (ft):	553082.07
Easting (ft):	1646641.87
Elevation (ft):	928.08

Detailed Description:

Inside corner concrete walk



GNSS CONTROL POINT LOCATION SHEET

Horizontal Datum: NAD83	Vertical Datum: NAVD88
Projection: WV South (4702)	Geoid: Geoid12B
Precisions (ft): H: 0.03 V: 0.04 @95% Conf	Method: VRS
Date: 2/21/2019	Operator: Freshour
Location: CABELL COUNTY, WV - Lesage	

19

Northing (ft):	539789.81
Easting (ft):	1596163.19
Elevation (ft):	573.26

Detailed Description:

Inside angle point concrete walk



GNSS CONTROL POINT LOCATION SHEET

Horizontal Datum: NAD83	Vertical Datum: NAVD88
Projection: WV South (4702)	Geoid: Geoid12B
Pecisions (ft): H: 0.04 V: 0.05 @95% Conf	Method: VRS
Date: 2/21/2019	Operator: Brown
Location: CABELL COUNTY, WV	

20

Northing (ft):	552388.99
Easting (ft):	1616234.28
Elevation (ft):	1000.44

Detailed Description:

Inside angle point concrete walk

