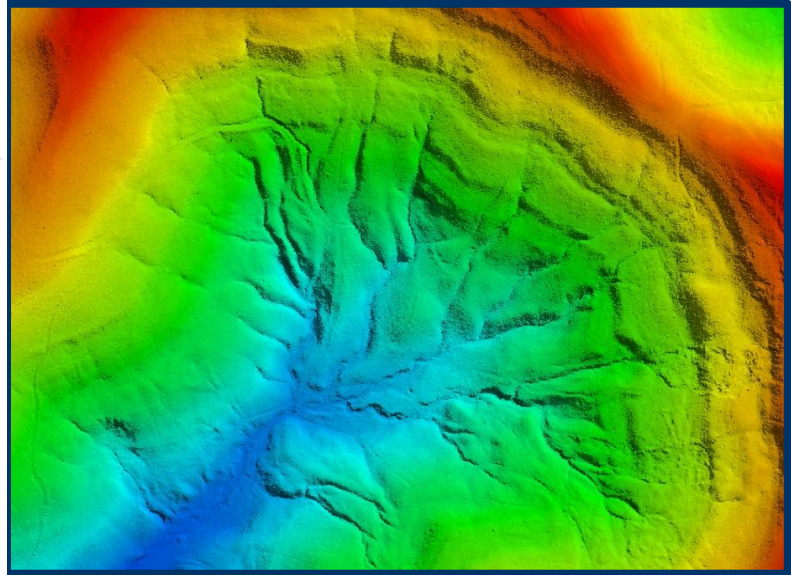


# AERIAL LIDAR ACQUISITION REPORT



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Elk Watershed  
LIDAR \*.LAS1.2 DATA  
COMPREHENSIVE AND BARE EARTH

**WEST VIRGINIA  
DEPARTMENT OF ENVIRONMENTAL PROTECTION**

JUNE 2013

PREPARED BY:

WVU NATURAL RESOURCE ANALYSIS CENTER  
2014 AGRICULTURAL SCIENCES  
PO BOX 6108  
MORGANTOWN, WV 26506-6108

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## SECTION 1: OVERVIEW

### Project Name: Elk Watershed Airborne LiDAR

NRAC was contracted to perform an aerial acquisition survey of the pertinent mine areas in and around the Elk Watershed (excluding data captured previously and delivered with the New River 'Bridge' data and the COE New River datasets), for the purpose of high-resolution (1-meter) airborne LiDAR to ultimately produce products (digital elevation models, contours, flood and surface modeling, change detection, permit boundaries, etc) for the public. The Elk Watershed project was collected between 18 Nov 2011 and 13 Dec 2011, and is composed of 846 working segments, covering 470,365.07 acres.

LiDAR data was collected by the Optech ALTM-3100 100k Hz Multi-pulse LiDAR system mounted in a Piper Navajo PA-31. The ALTM-3100 collects up to four returns per pulse, as well as backscatter reflectance (intensity) data. The aerial LiDAR was collected at the following sensor specifications:

Post Spacing (Average):	3.3 ft / 1.0 meter
Flying Height (Above Ground Level):	5,000-ft / 1,524 meters
Flying Height (Mean Sea Level):	Varies with terrain
Average Ground Speed:	135 knots (155 MPG)
Scanner Pulse Rate Frequency:	70,000 Hz
Scanner Frequency / Field of View:	35 Hz / 36 degrees (18 half angle)
Overlap (Average):	30%

Flight line acquisition was performed around weather, winds, GPS PDOP, vegetation emergence conditions, and fuel, collecting data in as few missions as possible, as close together as possible, to ensure consistency across the project area.

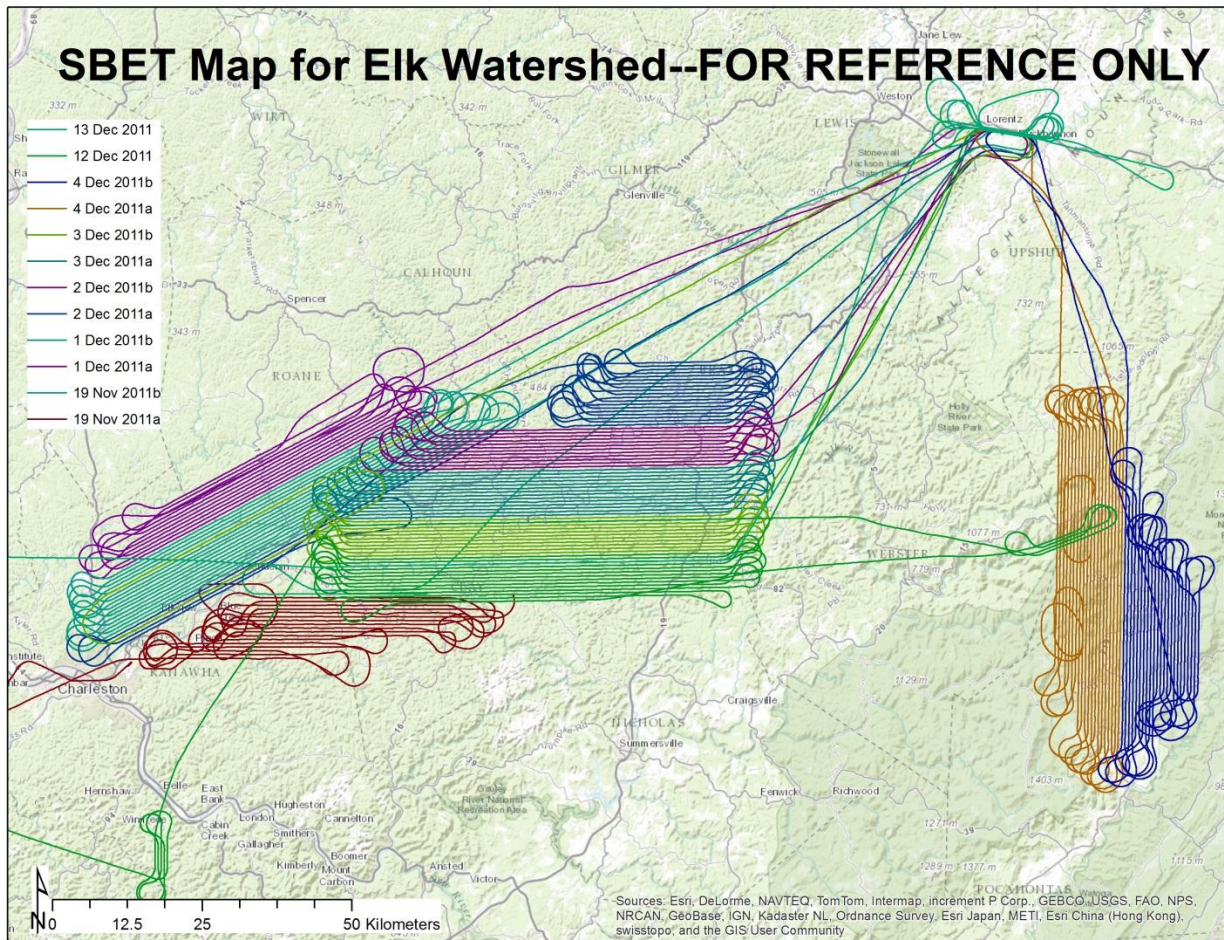
The data collected was flown back to the WVU NRAC office in Morgantown, WV, extracted, viewed, and quality controlled such that immediate re-flights could be performed if necessary.

NRAC's aerial acquisition team coordinated with the necessary Air Traffic Control and Restricted Airspace personnel prior to flying to ensure permissions.



# Flight Summary Log

Date of Flight	Lines/Trajectories	Start week/time (GPS, UTC)	Stop week/time (GPS, UTC)
19 Nov 2011	26	638/ 592162.3000	639/ 000000.0000
19 Nov 2011	5	639/ 000000.0000	639/ 001040.5300
1 Dec 2011	13	640/ 402477.3896	640/ 411297.4800
1 Dec 2011	16	640/ 422649.7206	640/ 436915.8283
2 Dec 2011	24	640/ 487736.4224	640/ 499958.6668
2 Dec 2011	13	640/ 507099.8582	640/ 516420.9065
3 Dec 2011	15	640/ 570852.6976	640/ 583336.9689
3 Dec 2011	13	640/ 589678.4311	640/ 600952.6650
4 Dec 2011	25	641/ 52589.5881	641/ 67971.9854
4 Dec 2011	24	641/ 75793.8922	641/ 86912.9180
12 Dec 2011	25	642/ 140512.4576	642/ 156771.6359
13 Dec 2011	4	642/ 227062.2486	642/ 229993.2902



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## SECTION 2: GPS BASE STATION DATA

Ground GPS data is collected via two TOPCON HiPER GD dual-frequency, 12-channel geodetic quality receivers. Locations occupied for collection are either registered National Geodetic Survey (NGS) control monuments, or created Online Positioning User's Service (NGS OPUS) control points.

NRAC determines appropriate locations for GPS base station collections and only operates equipment/occupies site with appropriate permissions. Locations are determined based off baseline length from rover (aircraft) to base stations, site assessments (view of sky, obstructions [masks], and multipath sources), along with permissions/access.

Base stations locations for the Tug Notch project area are detailed with the following NGS OPUS Datasheets (dates are referenced in file name):



FILE: Unit\_B\_1119p\_pinch18thpole.tps 000388749

NGS OPUS SOLUTION REPORT

All computed coordinate accuracies are listed as peak-to-peak values.  
For additional information: <http://www.ngs.noaa.gov/OPUS/about.html#accuracy>

USER: adam.riley@mail.wvu.edu DATE: November 21, 2011  
RINEX FILE: unit323p.11o TIME: 18:13:05 UTC

SOFTWARE: page5 1108.09 master81.pl 060711 START: 2011/11/19 15:07:00  
EPHEMERIS: igr16626.eph [rapid] STOP: 2011/11/20 00:56:00  
NAV FILE: brdc3230.11n OBS USED: 21832 / 22987 : 95%  
ANT NAME: TPSHIPER\_GD NONE # FIXED AMB: 122 / 127 : 96%  
ARP HEIGHT: 2.0 OVERALL RMS: 0.015(m)

REF FRAME: NAD\_83(CORS96)(EPOCH:2002.0000) ITRF00 (EPOCH:2011.8845)

X:	741302.331(m)	0.005(m)	741301.568(m)	0.005(m)
Y:	-4949961.856(m)	0.024(m)	-4949960.424(m)	0.024(m)
Z:	3940434.409(m)	0.021(m)	3940434.281(m)	0.021(m)

LAT:	38 23 58.66282	0.020(m)	38 23 58.69037	0.020(m)
E LON:	278 31 2.17901	0.008(m)	278 31 2.15665	0.008(m)
W LON:	81 28 57.82099	0.008(m)	81 28 57.84335	0.008(m)
EL HGT:	210.412(m)	0.024(m)	209.134(m)	0.024(m)
ORTHO HGT:	243.336(m)	0.043(m)	[NAVD88 (Computed using GEOID09)]	

	UTM COORDINATES	STATE PLANE COORDINATES
	UTM (Zone 17)	SPC (4702 WV S)
Northing (Y) [meters]	4250266.447	155453.523
Easting (X) [meters]	457848.677	557834.953
Convergence [degrees]	-0.29984742	-0.29842027
Point Scale	0.99962188	0.99993271
Combined Factor	0.99958888	0.99989969

US NATIONAL GRID DESIGNATOR: 17SMC5784850266(NAD 83)

		BASE STATIONS USED		
PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DI1661	LOYE LOYOLA E COOP CORS ARP	N384908.742	W0814240.873	50644.9
DH9001	WVHU MARSHALL UNIV-HUN CORS ARP	N382522.617	W0822528.918	82313.8
DL9814	WVOH OAK HILL CORS ARP	N375953.723	W0810755.787	54114.4

		NEAREST NGS PUBLISHED CONTROL POINT		
PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
HX1921	W 7	N382529.	W0812916.	2827.9

This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.



| FILE: Unit\_A\_120in\_PinchPlateau.tps OP1323873695646

NGS OPUS SOLUTION REPORT  
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All computed coordinate accuracies are listed as peak-to-peak values.  
For additional information: <http://www.ngs.noaa.gov/OPUS/about.html#accuracy>

USER: adam.riley@mail.wvu.edu  
RINEX FILE: unit335n.11o

DATE: December 14, 2011  
TIME: 14:44:02 UTC

SOFTWARE: page5 1108.09 master28.pl 060711      START: 2011/12/01 13:48:00  
EPHEMERIS: igr16644.eph [rapid]                      STOP: 2011/12/02 01:07:00  
NAV FILE: brdc3350.11n                                OBS USED: 23592 / 24445 : 97%  
ANT NAME: TPSHIPER\_GD                                # FIXED AMB: 102 / 106 : 96%  
ARP HEIGHT: 2.0                                        OVERALL RMS: 0.014(m)

REF FRAME: NAD\_83(CORS96)(EPOCH:2002.0000)                      ITRF00 (EPOCH:2011.9173)

X:	741274.611(m)	0.003(m)	741273.848(m)	0.003(m)
Y:	-4949945.922(m)	0.011(m)	-4949944.490(m)	0.011(m)
Z:	3940458.491(m)	0.010(m)	3940458.364(m)	0.010(m)

LAT:	38 23 59.67501	0.008(m)	38 23 59.70259	0.008(m)
E LON:	278 31 1.14650	0.003(m)	278 31 1.12415	0.003(m)
W LON:	81 28 58.85350	0.003(m)	81 28 58.87585	0.003(m)
EL HGT:	209.803(m)	0.013(m)	208.526(m)	0.013(m)
ORTHO HGT:	242.729(m)	0.026(m)	[NAVD88 (Computed using GEOID09)]	

	UTM COORDINATES	STATE PLANE COORDINATES
	UTM (Zone 17)	SPC (4702 wv S)
Northing (Y) [meters]	4250297.776	155484.862
Easting (X) [meters]	457823.796	557810.064
Convergence [degrees]	-0.30002743	-0.29859757
Point Scale	0.99962191	0.99993272
Combined Factor	0.99958900	0.99989981

US NATIONAL GRID DESIGNATOR: 17SMC5782350297(NAD 83)

		BASE STATIONS USED		
PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DH9001	WVHU MARSHALL UNIV-HUN CORS ARP	N382522.617	w0822528.918	82287.7
DM2710	WVMZ MOUNT ZION CORS ARP	N385020.043	w0810631.583	58628.2
DH9003	WVRA MARSHALL UNIV-RAV CORS ARP	N385628.863	w0814504.842	64483.4

		NEAREST NGS PUBLISHED CONTROL POINT		
PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
HX1921	w 7	N382529.	w0812916.	2793.2

This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.



| FILE: Unit\_B\_1201m\_OvapaOPUS.tps OP1323875042324

NGS OPUS SOLUTION REPORT  
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All computed coordinate accuracies are listed as peak-to-peak values.  
For additional information: <http://www.ngs.noaa.gov/OPUS/about.html#accuracy>

USER: adam.riley@mail.wvu.edu  
RINEX FILE: unit335m.11o

DATE: December 14, 2011  
TIME: 15:06:49 UTC

SOFTWARE: page5 1108.09 master10.pl 060711      START: 2011/12/01 12:39:00  
EPHEMERIS: igr16644.eph [rapid]                      STOP: 2011/12/02 01:31:00  
NAV FILE: brdc3350.11n                              OBS USED: 25943 / 26976 : 96%  
ANT NAME: TPSHIPER\_GD                              # FIXED AMB: 115 / 118 : 97%  
ARP HEIGHT: 2.0                                      OVERALL RMS: 0.014(m)

REF FRAME: NAD\_83(CORS96) (EPOCH:2002.0000)                      ITRF00 (EPOCH:2011.9172)

X:	770342.804(m)	0.026(m)	770342.040(m)	0.026(m)
Y:	-4937830.506(m)	0.028(m)	-4937829.074(m)	0.028(m)
Z:	3950148.403(m)	0.018(m)	3950148.277(m)	0.018(m)

LAT:	38 30 38.69776	0.020(m)	38 30 38.72551	0.020(m)
E LON:	278 52 1.71573	0.028(m)	278 52 1.69368	0.028(m)
W LON:	81 7 58.28427	0.028(m)	81 7 58.30632	0.028(m)
EL HGT:	297.488(m)	0.024(m)	296.210(m)	0.024(m)
ORTHO HGT:	330.062(m)	0.043(m)	[NAVD88 (Computed using GEOID09)]	

	UTM COORDINATES	STATE PLANE COORDINATES
	UTM (Zone 17)	SPC (4702 WV S)
Northing (Y) [meters]	4262494.558	167686.222
Easting (X) [meters]	488416.894	588412.939
Convergence [degrees]	-0.08272486	-0.08213143
Point Scale	0.99960165	0.99994185
Combined Factor	0.99955500	0.99989518

US NATIONAL GRID DESIGNATOR: 17SMC8841662494(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DE9159	GSSP GLENVILLE COOP CORS ARP	N385644.520	W0804933.463	55170.2
DI1661	LOYE LOYOLA E COOP CORS ARP	N384908.742	W0814240.873	60883.9
DM2710	WVMZ MOUNT ZION CORS ARP	N385020.043	W0810631.583	36489.8

NEAREST NGS PUBLISHED CONTROL POINT

HX3016	MAYSEL	N382949.448	W0810733.818	1633.9
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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NGS OPUS SOLUTION REPORT  
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All computed coordinate accuracies are listed as peak-to-peak values.  
For additional information: <http://www.ngs.noaa.gov/OPUS/about.html#accuracy>

USER: adam.riley@mail.wvu.edu  
RINEX FILE: unit336n.11o

DATE: December 14, 2011  
TIME: 15:12:13 UTC

SOFTWARE: page5 1108.09 master10.pl 060711      START: 2011/12/02 13:29:00  
EPHEMERIS: igr16645.eph [rapid]                  STOP: 2011/12/03 00:31:00  
NAV FILE: brdc3360.11n                            OBS USED: 22238 / 24056 : 92%  
ANT NAME: TPSHIPER\_GD                           # FIXED AMB: 131 / 138 : 95%  
ARP HEIGHT: 2.0                                  OVERALL RMS: 0.015(m)

REF FRAME: NAD\_83(CORS96)(EPOCH:2002.0000)      ITRF00 (EPOCH:2011.9200)

X:	809842.017(m)	0.016(m)	809841.252(m)	0.016(m)
Y:	-4919292.536(m)	0.011(m)	-4919291.104(m)	0.011(m)
Z:	3965333.133(m)	0.022(m)	3965333.010(m)	0.022(m)

LAT:	38 41 7.36060	0.012(m)	38 41 7.38864	0.012(m)
E LON:	279 20 54.62473	0.017(m)	279 20 54.60313	0.017(m)
W LON:	80 39 5.37527	0.017(m)	80 39 5.39687	0.017(m)
EL HGT:	351.463(m)	0.020(m)	350.187(m)	0.020(m)
ORTHO HGT:	383.548(m)	0.036(m)	[NAVD88 (Computed using GEOID09)]	

	UTM COORDINATES	STATE PLANE COORDINATES
	UTM (Zone 17)	SPC (4702 wv S)
Northing (Y) [meters]	4281921.198	187119.134
Easting (X) [meters]	530311.052	630321.971
Convergence [degrees]	0.21783360	0.21544535
Point Scale	0.99961131	0.99996382
Combined Factor	0.99955619	0.99990868

US NATIONAL GRID DESIGNATOR: 17SNC3031181921(NAD 83)

BASE STATIONS USED				
PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DM2710	WVMZ MOUNT ZION CORS ARP	N385020.043	w0810631.583	43246.8
DM4710	WVNR ELKINS CORS ARP	N385344.505	w0795130.270	72757.3
DM5974	WVBR BRIDGEPORT CORS ARP	N391828.884	w0801638.619	76346.6

NEAREST NGS PUBLISHED CONTROL POINT				
PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
HX1558	K 278	N384108.	w0803904.	38.6

This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

| FILE: unit\_B\_1202o\_ovapa\_OPUS.tps OP1323875642023

NGS OPUS SOLUTION REPORT

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All computed coordinate accuracies are listed as peak-to-peak values.  
For additional information: <http://www.ngs.noaa.gov/OPUS/about.html#accuracy>

USER: adam.riley@mail.wvu.edu  
RINEX FILE: unit3360.11o

DATE: December 14, 2011  
TIME: 15:15:40 UTC

SOFTWARE: page5 1108.09 master81.pl 060711      START: 2011/12/02 14:30:00  
EPHEMERIS: igr16645.eph [rapid]                    STOP: 2011/12/03 00:46:00  
NAV FILE: brdc3360.11n                            OBS USED: 21033 / 22282 : 94%  
ANT NAME: TPSHIPER\_GD                            # FIXED AMB: 142 / 152 : 93%  
ARP HEIGHT: 2.0                                   OVERALL RMS: 0.015(m)

REF FRAME: NAD\_83(CORS96) (EPOCH:2002.0000)      ITRF00 (EPOCH:2011.9200)

X:	770342.816(m)	0.008(m)	770342.052(m)	0.008(m)
Y:	-4937830.495(m)	0.025(m)	-4937829.063(m)	0.025(m)
Z:	3950148.394(m)	0.019(m)	3950148.268(m)	0.019(m)
LAT:	38 30 38.69772	0.018(m)	38 30 38.72547	0.018(m)
E LON:	278 52 1.71629	0.012(m)	278 52 1.69424	0.012(m)
W LON:	81 7 58.28371	0.012(m)	81 7 58.30576	0.012(m)
EL HGT:	297.475(m)	0.026(m)	296.197(m)	0.026(m)
ORTHO HGT:	330.049(m)	0.046(m)	[NAVD88 (Computed using GEOID09)]	

	UTM COORDINATES	STATE PLANE COORDINATES
	UTM (Zone 17)	SPC (4702 WV S)
Northing (Y) [meters]	4262494.556	167686.221
Easting (X) [meters]	488416.908	588412.953
Convergence [degrees]	-0.08272477	-0.08213133
Point Scale	0.99960165	0.99994185
Combined Factor	0.99955500	0.99989518

US NATIONAL GRID DESIGNATOR: 17SMC8841662494(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DI1661	LOYE LOYOLA E COOP CORS ARP	N384908.742	w0814240.873	60883.9
DM2710	WVMZ MOUNT ZION CORS ARP	N385020.043	w0810631.583	36489.8
DH9003	WVRA MARSHALL UNIV-RAV CORS ARP	N385628.863	w0814504.842	71957.6

NEAREST NGS PUBLISHED CONTROL POINT

HX3016	MAYSEL	N382949.448	w0810733.818	1633.9
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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| FILE: Unit\_A\_1203o\_BigDitch\_Center.tps OP1323875948066

NGS OPUS SOLUTION REPORT  
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All computed coordinate accuracies are listed as peak-to-peak values.  
For additional information: <http://www.ngs.noaa.gov/OPUS/about.html#accuracy>

USER: adam.riley@mail.wvu.edu  
RINEX FILE: unit337o.11o

DATE: December 14, 2011  
TIME: 15:20:31 UTC

SOFTWARE: page5 1108.09 master81.pl 060711      START: 2011/12/03 14:09:00  
EPHEMERIS: igr16646.eph [rapid]                    STOP: 2011/12/03 23:26:00  
NAV FILE: brdc3370.11n                            OBS USED: 20308 / 21483 : 95%  
ANT NAME: TPSHIPER\_GD                            # FIXED AMB: 106 / 112 : 95%  
ARP HEIGHT: 2.0                                    OVERALL RMS: 0.015(m)

REF FRAME: NAD\_83(CORS96) (EPOCH:2002.0000)      ITRF00 (EPOCH:2011.9227)

X:	820124.204(m)	0.017(m)	820123.440(m)	0.017(m)
Y:	-4937500.034(m)	0.005(m)	-4937498.598(m)	0.005(m)
Z:	3941168.958(m)	0.025(m)	3941168.833(m)	0.025(m)

LAT:	38 24 17.61457	0.017(m)	38 24 17.64245	0.017(m)
E LON:	279 25 50.84662	0.016(m)	279 25 50.82526	0.016(m)
W LON:	80 34 9.15338	0.016(m)	80 34 9.17474	0.016(m)
EL HGT:	655.642(m)	0.018(m)	654.356(m)	0.018(m)
ORTHO HGT:	686.722(m)	0.034(m)	[NAVD88 (Computed using GEOID09)]	

	UTM COORDINATES	STATE PLANE COORDINATES
	UTM (Zone 17)	SPC (4702 WV S)
Northing (Y) [meters]	4250828.127	156015.488
Easting (X) [meters]	537613.460	637625.775
Convergence [degrees]	0.26761667	0.26631285
Point Scale	0.99961742	0.99993305
Combined Factor	0.99951460	0.99983020

US NATIONAL GRID DESIGNATOR: 17SNC3761350828(NAD 83)

		BASE STATIONS USED		
PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DM2710	WVMZ MOUNT ZION CORS ARP	N385020.043	W0810631.583	67303.7
DM2708	WVLE LEWISBURG CORS ARP	N374920.202	W0802518.557	65954.9
DL9814	WVOH OAK HILL CORS ARP	N375953.723	W0810755.787	66855.1

		NEAREST NGS PUBLISHED CONTROL POINT		
PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
HX1015	C 228	N382353.	W0803353.	855.9

This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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| FILE: Unit\_B\_1203m\_ovapa\_OPUS.tps OP1323876040855

NGS OPUS SOLUTION REPORT

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All computed coordinate accuracies are listed as peak-to-peak values.  
For additional information: <http://www.ngs.noaa.gov/OPUS/about.html#accuracy>

USER: adam.riley@mail.wvu.edu  
RINEX FILE: unit337m.11o

DATE: December 14, 2011  
TIME: 15:23:08 UTC

SOFTWARE: page5 1108.09 master10.pl 060711      START: 2011/12/03 12:43:00  
EPHEMERIS: igr16646.eph [rapid]                      STOP: 2011/12/04 00:40:00  
NAV FILE: brdc3370.11n                              OBS USED: 26521 / 27593 : 96%  
ANT NAME: TPSHIPER\_GD                              # FIXED AMB: 110 / 119 : 92%  
ARP HEIGHT: 2.0                                      OVERALL RMS: 0.014(m)

REF FRAME: NAD\_83(CORS96) (EPOCH:2002.0000)                      ITRF00 (EPOCH:2011.9227)

X:	770342.800(m)	0.026(m)	770342.036(m)	0.026(m)
Y:	-4937830.499(m)	0.027(m)	-4937829.067(m)	0.027(m)
Z:	3950148.400(m)	0.013(m)	3950148.274(m)	0.013(m)
LAT:	38 30 38.69784	0.023(m)	38 30 38.72559	0.023(m)
E LON:	278 52 1.71561	0.027(m)	278 52 1.69356	0.027(m)
W LON:	81 7 58.28439	0.027(m)	81 7 58.30644	0.027(m)
EL HGT:	297.480(m)	0.021(m)	296.202(m)	0.021(m)
ORTHO HGT:	330.054(m)	0.038(m)	[NAVD88 (Computed using GEOID09)]	

	UTM COORDINATES	STATE PLANE COORDINATES
	UTM (Zone 17)	SPC (4702 WV S)
Northing (Y) [meters]	4262494.560	167686.224
Easting (X) [meters]	488416.891	588412.936
Convergence [degrees]	-0.08272488	-0.08213145
Point Scale	0.99960165	0.99994185
Combined Factor	0.99955500	0.99989518

US NATIONAL GRID DESIGNATOR: 17SMC8841662494(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DE9159	GSSP GLENVILLE COOP CORS ARP	N385644.520	w0804933.463	55170.2
DM2710	WVMZ MOUNT ZION CORS ARP	N385020.043	w0810631.583	36489.8
DI1661	LOYE LOYOLA E COOP CORS ARP	N384908.742	w0814240.873	60883.9

NEAREST NGS PUBLISHED CONTROL POINT

HX3016	MAYSEL	N382949.448	w0810733.818	1633.9
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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| FILE: Unit\_A\_1204na\_PolingTower.tps OP1323876231770

NGS OPUS SOLUTION REPORT

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All computed coordinate accuracies are listed as peak-to-peak values.  
For additional information: <http://www.ngs.noaa.gov/OPUS/about.html#accuracy>

USER: adam.riley@mail.wvu.edu  
RINEX FILE: unit338n.11o

DATE: December 14, 2011  
TIME: 15:25:40 UTC

SOFTWARE: page5 1108.09 master80.pl 060711      START: 2011/12/04 13:09:00  
EPHEMERIS: igr16650.eph [rapid]                    STOP: 2011/12/05 01:16:30  
NAV FILE: brdc3380.11n                            OBS USED: 26856 / 28774 : 93%  
ANT NAME: TPSHIPER\_GD                            # FIXED AMB: 139 / 145 : 96%  
ARP HEIGHT: 2.0                                    OVERALL RMS: 0.015(m)

REF FRAME: NAD\_83(CORS96)(EPOCH:2002.0000)                    ITRF00 (EPOCH:2011.9255)

X:	859979.742(m)	0.009(m)	859978.977(m)	0.009(m)
Y:	-4920519.035(m)	0.011(m)	-4920517.599(m)	0.011(m)
Z:	3954308.928(m)	0.013(m)	3954308.805(m)	0.013(m)

LAT:	38 33 13.81518	0.009(m)	38 33 13.84331	0.009(m)
E LON:	279 54 49.29000	0.009(m)	279 54 49.26909	0.009(m)
W LON:	80 5 10.71000	0.009(m)	80 5 10.73091	0.009(m)
EL HGT:	969.384(m)	0.012(m)	968.098(m)	0.012(m)
ORTHO HGT:	999.905(m)	0.025(m)	[NAVD88 (Computed using GEOID09)]	

	UTM COORDINATES	STATE PLANE COORDINATES
	UTM (Zone 17)	SPC (4702 WV S)
Northing (Y) [meters]	4267663.007	172853.276
Easting (X) [meters]	579613.392	679638.930
Convergence [degrees]	0.56948798	0.56483999
Point Scale	0.99967805	0.99994641
Combined Factor	0.99952602	0.99979434

US NATIONAL GRID DESIGNATOR: 17SNC7961367663(NAD 83)

PID	DESIGNATION	BASE STATIONS USED		
		LATITUDE	LONGITUDE	DISTANCE(m)
DM4710	WVNR ELKINS CORS ARP	N385344.505	W0795130.270	42819.9
DM4706	WVCV CANAAN VALLEY CORS ARP	N390055.076	W0792725.010	74941.3
DL3933	LS08 LOYOLA LS08 CORS ARP	N385849.217	W0801311.035	48754.0

NEAREST NGS PUBLISHED CONTROL POINT				
		LATITUDE	LONGITUDE	DISTANCE(m)
HX0043	J 15	N383302.	W0800511.	365.4

This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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| FILE: Unit\_B\_1204n\_PotatoKnob.tps OP1323876367085

NGS OPUS SOLUTION REPORT

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All computed coordinate accuracies are listed as peak-to-peak values.  
For additional information: <http://www.ngs.noaa.gov/OPUS/about.html#accuracy>

USER: adam.riley@mail.wvu.edu  
RINEX FILE: unit338n.11o

DATE: December 14, 2011  
TIME: 15:28:30 UTC

SOFTWARE: page5 1108.09 master40.pl 060711      START: 2011/12/04 13:43:00  
EPHEMERIS: igr16650.eph [rapid]                    STOP: 2011/12/05 00:46:00  
NAV FILE: brdc3380.11n                            OBS USED: 21701 / 25642 : 85%  
ANT NAME: TPSHIPER\_GD                            # FIXED AMB: 156 / 166 : 94%  
ARP HEIGHT: 2.0                                    OVERALL RMS: 0.017(m)

REF FRAME: NAD\_83(CORS96) (EPOCH:2002.0000)                    ITRF00 (EPOCH:2011.9255)

X:	838522.495(m)	0.012(m)	838521.731(m)	0.012(m)
Y:	-4927314.047(m)	0.026(m)	-4927312.611(m)	0.026(m)
Z:	3950443.754(m)	0.008(m)	3950443.630(m)	0.008(m)

LAT:	38 30 34.18229	0.014(m)	38 30 34.21031	0.014(m)
E LON:	279 39 28.72916	0.014(m)	279 39 28.70802	0.014(m)
W LON:	80 20 31.27084	0.014(m)	80 20 31.29198	0.014(m)
EL HGT:	946.827(m)	0.020(m)	945.541(m)	0.020(m)
ORTHO HGT:	977.749(m)	0.036(m)	[NAVD88 (Computed using GEOID09)]	

	UTM COORDINATES	STATE PLANE COORDINATES
	UTM (Zone 17)	SPC (4702 WV 5)
Northing (Y) [meters]	4262552.121	167742.392
Easting (X) [meters]	557367.238	657386.081
Convergence [degrees]	0.40969888	0.40676041
Point Scale	0.99964053	0.99994172
Combined Factor	0.99949204	0.99979319

US NATIONAL GRID DESIGNATOR: 17SNC5736762552(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DM2708	WVLE LEWISBURG CORS ARP	N374920.202	w0802518.557	76610.4
DM4710	WVNR ELKINS CORS ARP	N385344.505	w0795130.270	60072.5
DL3933	LS08 LOYOLA LS08 CORS ARP	N385849.217	w0801311.035	53347.0

NEAREST NGS PUBLISHED CONTROL POINT

HX2860	WEBSTER SPRINGS ATT MICROWAVE	N383035.922	w0802031.925	56.1
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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| FILE: Unit\_A\_1212n\_BigDitchCENTER.tps OP1323876799373

NGS OPUS SOLUTION REPORT  
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All computed coordinate accuracies are listed as peak-to-peak values.  
For additional information: <http://www.ngs.noaa.gov/OPUS/about.html#accuracy>

USER: adam.riley@mail.wvu.edu  
RINEX FILE: unit346n.11o

DATE: December 14, 2011  
TIME: 15:34:29 UTC

SOFTWARE: page5 1108.09 master80.pl 060711      START: 2011/12/12 13:10:00  
EPHEMERIS: igr16661.eph [rapid]                      STOP: 2011/12/12 20:16:00  
NAV FILE: brdc3460.11n                              OBS USED: 15393 / 16295 : 94%  
ANT NAME: TPSHIPER\_GD                              # FIXED AMB: 90 / 91 : 99%  
ARP HEIGHT: 2.0                                      OVERALL RMS: 0.015(m)

REF FRAME: NAD\_83(CORS96) (EPOCH:2002.0000)                      ITRF00 (EPOCH:2011.9471)

X:	820124.221(m)	0.018(m)	820123.457(m)	0.018(m)
Y:	-4937500.022(m)	0.014(m)	-4937498.586(m)	0.014(m)
Z:	3941168.952(m)	0.009(m)	3941168.827(m)	0.009(m)
LAT:	38 24 17.61460	0.012(m)	38 24 17.64248	0.012(m)
E LON:	279 25 50.84740	0.017(m)	279 25 50.82603	0.017(m)
W LON:	80 34 9.15260	0.017(m)	80 34 9.17397	0.017(m)
EL HGT:	655.631(m)	0.013(m)	654.345(m)	0.013(m)
ORTHO HGT:	686.711(m)	0.026(m)	[NAVD88 (Computed using GEOID09)]	

	UTM COORDINATES	STATE PLANE COORDINATES
	UTM (Zone 17)	SPC (4702 WV S)
Northing (Y) [meters]	4250828.128	156015.489
Easting (X) [meters]	537613.478	637625.793
Convergence [degrees]	0.26761680	0.26631298
Point Scale	0.99961742	0.99993305
Combined Factor	0.99951460	0.99983020

US NATIONAL GRID DESIGNATOR: 17SNC3761350828(NAD 83)

BASE STATIONS USED			
PID	DESIGNATION	LATITUDE	LONGITUDE DISTANCE(m)
DM2708	WVLE LEWISBURG CORS ARP	N374920.202	W0802518.557 65954.9
DL3933	LS08 LOYOLA LS08 CORS ARP	N385849.217	W0801311.035 70752.4
DL9814	WVOH OAK HILL CORS ARP	N375953.723	W0810755.787 66855.1

NEAREST NGS PUBLISHED CONTROL POINT			
PID	DESIGNATION	LATITUDE	LONGITUDE DISTANCE(m)
HX1015	C 228	N382353.	W0803353. 855.9

This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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| FILE: Unit\_B\_12121a\_Ovapa\_OPUS.tps OP1323876854255

NGS OPUS SOLUTION REPORT

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All computed coordinate accuracies are listed as peak-to-peak values.  
For additional information: <http://www.ngs.noaa.gov/OPUS/about.html#accuracy>

USER: adam.riley@mail.wvu.edu  
RINEX FILE: unit3461.11o

DATE: December 14, 2011  
TIME: 15:35:38 UTC

SOFTWARE: page5 1108.09 master81.pl 060711      START: 2011/12/12 11:55:00  
EPHEMERIS: igr16661.eph [rapid]                      STOP: 2011/12/12 21:24:30  
NAV FILE: brdc3460.11n                              OBS USED: 21188 / 22294 : 95%  
ANT NAME: TPSHIPER\_GD                              # FIXED AMB: 107 / 114 : 94%  
ARP HEIGHT: 2.0                                      OVERALL RMS: 0.015(m)

REF FRAME: NAD\_83(CORS96)(EPOCH:2002.0000)                      ITRF00 (EPOCH:2011.9471)

X:	770342.814(m)	0.006(m)	770342.050(m)	0.006(m)
Y:	-4937830.504(m)	0.030(m)	-4937829.072(m)	0.030(m)
Z:	3950148.398(m)	0.009(m)	3950148.272(m)	0.009(m)

LAT:	38 30 38.69765	0.022(m)	38 30 38.72540	0.022(m)
E LON:	278 52 1.71615	0.007(m)	278 52 1.69410	0.007(m)
W LON:	81 7 58.28385	0.007(m)	81 7 58.30590	0.007(m)
EL HGT:	297.484(m)	0.021(m)	296.206(m)	0.021(m)
ORTHO HGT:	330.058(m)	0.038(m)	[NAVD88 (Computed using GEOID09)]	

	UTM COORDINATES	STATE PLANE COORDINATES
	UTM (Zone 17)	SPC (4702 WV S)
Northing (Y) [meters]	4262494.554	167686.218
Easting (X) [meters]	488416.904	588412.949
Convergence [degrees]	-0.08272479	-0.08213136
Point Scale	0.99960165	0.99994185
Combined Factor	0.99955500	0.99989518

US NATIONAL GRID DESIGNATOR: 17SMC8841662494(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DI1661	LOYE LOYOLA E COOP CORS ARP	N384908.742	W0814240.873	60883.9
DH9003	WVRA MARSHALL UNIV-RAV CORS ARP	N385628.863	W0814504.842	71957.6
DM2710	WVMZ MOUNT ZION CORS ARP	N385020.043	W0810631.583	36489.8

NEAREST NGS PUBLISHED CONTROL POINT

HX3016	MAYSEL	N382949.448	W0810733.818	1633.9
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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## SECTION 4: LIDAR SYSTEMS SPECIFICATIONS



*The OPTECH ALTM-3100*

1. NRAC operates an OPTECH ALTM-3100C airborne laser mapping system. The system integrates a laser Altimeter, a high-end Applanix POS/AV Inertial Measurement Unit (IMU), also called an Inertial Navigation System (INS), and a dual frequency Trimble GPS receiver. The system offers several user-configurable parameters that allow the data capture campaign to be tailored to each specific project. This integrated system is capable of 100kHz operation at an operating height of 1,100 meters (3,609 feet). LiDAR technology offers fast, real-time collection of three-dimensional points that are employed in the creation of Digital Elevation Models (DEMs) and other desired deliverables.
2. In-flight data are logged to hard drives, which provides for immediate extraction and viewing of post-mission data. Data quality, coverage, and other mission critical information are reviewed immediately to determine if re-flights are necessary. Basic parameters of NRAC's LiDAR system include:

<b>OPTECH ALTM-3100 LiDAR</b>	
Operating Altitude	80-3500 meters nominal
Horizontal Accuracy	1/2000 x altitude; 1 $\sigma$
Elevation Accuracy	<15 cm @ 1200m; 1 $\sigma$
Range Resolution	1 cm
Range Capture	Up to 4 range measurements for each pulse
Intensity Capture	12-bit dynamic range for each measurement
Scan Frequency	Variable; maximum 70 Hz
Scan Angle	Variable from 0 to 25°; in increments of 1°
Swath width	Variable; 0 to 0.93 x altitude (m)