Ground Control Point Survey Report

"CHESAPEAKE BAY, Virginia QL2 LiDAR"
USGS Contract: G10PC00013
Task Order Number: G15PD00714

Prepared for:
United States Geological Survey (USGS)

Prepared By:

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1. INTRODUCTION

1.1 *Project Summary*

Dewberry Consultants LLC is under contract to the United States Geological Survey to provide 62 Ground Control Points in the State of Virginia. Under the above referenced USGS Task Order, Dewberry is tasked to complete the quality assurance of LiDAR products. As part of this work Dewberry staff will complete Ground Control Point surveys that will be used to evaluate vertical and horizontal accuracy. The ground survey was conducted November 18-21 & November 30 – December 5, 2015.

Existing NGS Control Points were located and surveyed to check the accuracy of the RTK/GPS survey equipment with the results shown in Section 2.4 of this Report.

As an internal QA/QC procedure and to verify that the Ground Control Points meet the 95% confidence level approximately 50% of the points were re-observed and are shown in Section 5 of this report.

Final horizontal coordinates are referenced to UTM Zone 17 North, NAD83 in meters. Final Vertical elevations are referenced to NAVD88 in meters using Geoid model 2012B (Geoid12B).

1.2 *Points of Contact*

Questions regarding the technical aspects of this report should be addressed to:

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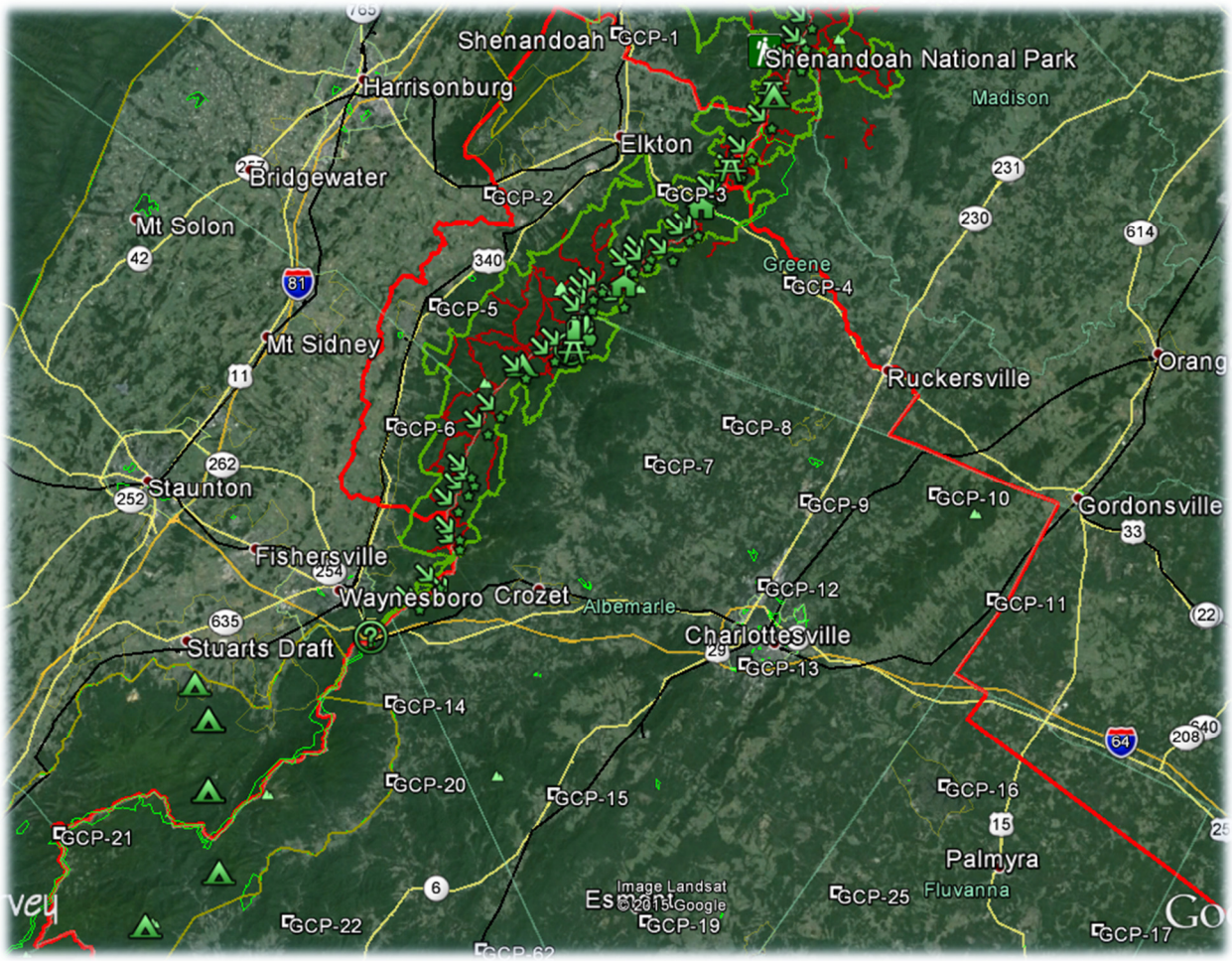
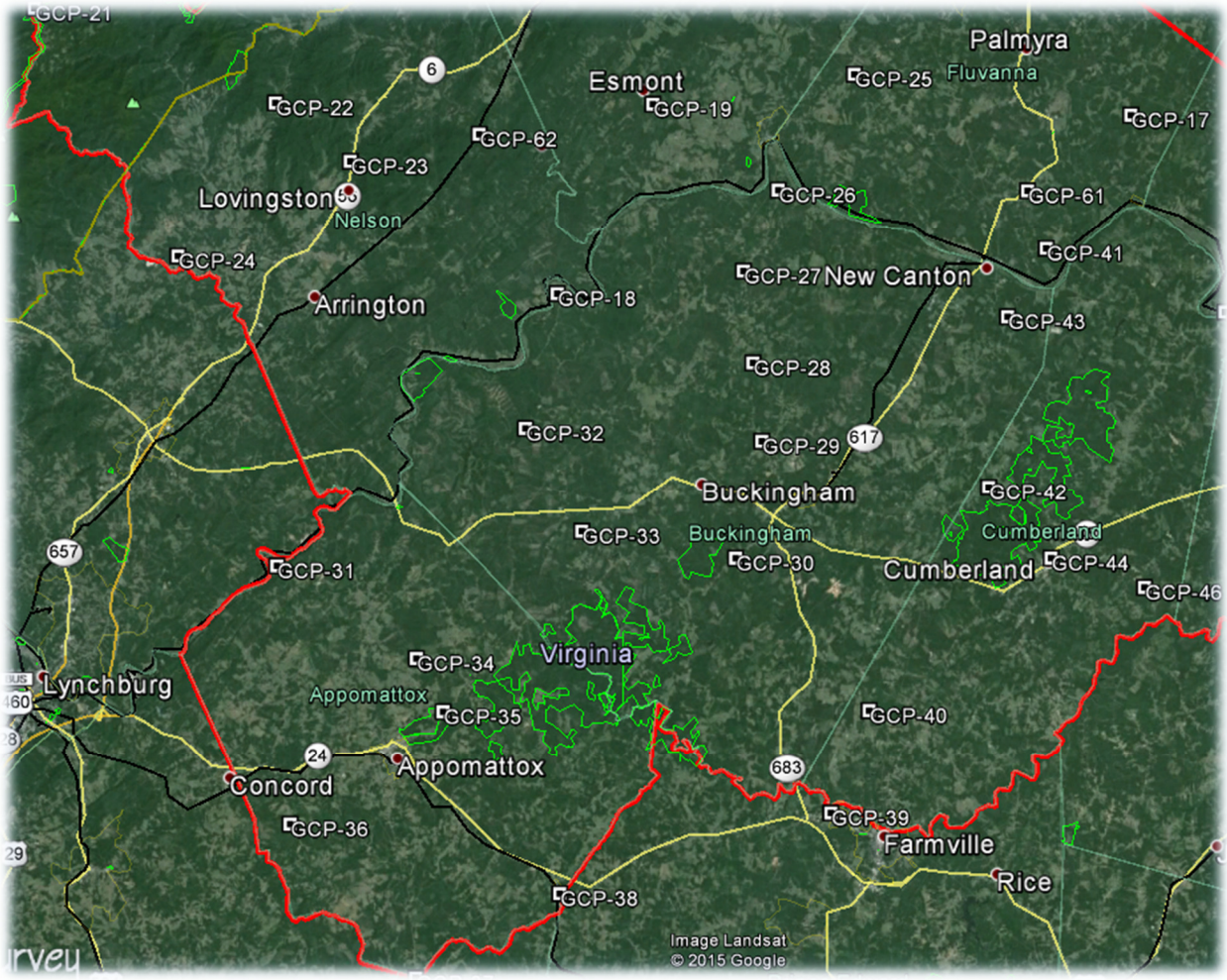
1.3 *Project Area*




GCP-21
Palmyra
Fluvanna
Esmont
GCP-25
GCP-19
GCP-17
6
GCP-22
GCP-62
GCP-23
Lovingston
Nelson
GCP-26
GCP-61
GCP-24
GCP-41
GCP-27
New Canton
Arrington
GCP-18
GCP-43
GCP-28
GCP-32
GCP-29
617
Buckingham
GCP-42
GCP-33
Buckingham
Cumberland
657
GCP-31
GCP-30
Cumberland
GCP-44
GCP-46
Virginia
GCP-34
Lynchburg
Appomattox
GCP-35
GCP-40
24
683
Concord
Appomattox
GCP-39
GCP-36
Farmville
Rice
GCP-38
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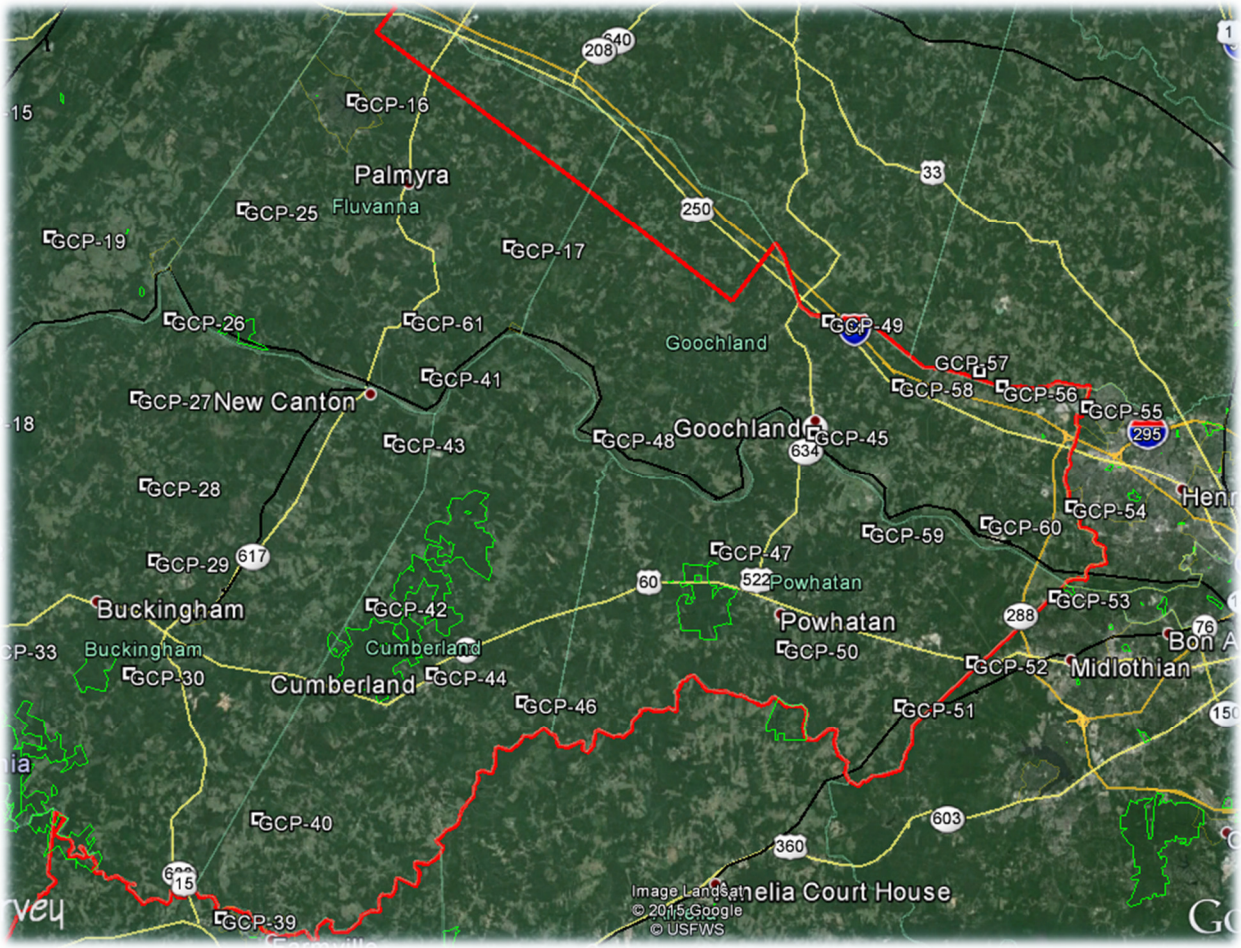
GCP-16
Palmyra
Fluvanna
GCP-25
GCP-19
GCP-17
GCP-26
GCP-61
GCP-41
GCP-27
New Canton
GCP-43
GCP-48
Goochland
GCP-45
GCP-49
GCP-57
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Powhatan
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Midlothian
GCP-30
GCP-44
GCP-46
GCP-51
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Image Landsat
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PROJECT DETAILS

2.1 *Survey Equipment*

In performing the GPS observations Trimble R-10 GNSS receiver/antenna attached to a two meter fixed height pole with a Trimble TSC3 Data Collector to collect GPS raw data were used to perform the field surveys.

2.2 *Survey Point Detail*

The 62 Ground Control Points were well distributed throughout the project area.

A sketch was made for each location and a nail was set at the point where possible or at an identifiable point. The Ground Control Point locations are detailed on the "Check Point Documentation Report" sheets attached to this report.

2.3 *Network Design*

The GPS survey performed by Dewberry Consultants LLC office located in Lanham, MD was tied to a Real Time Network (RTN) managed by KEYNET GPS, Inc. The network is a series of "real-time" continuously operating, high precision GPS reference stations. All of the reference stations have been linked together using Trimble GPSNet software, creating a Virtual Reference Station System (VRS).

The Trimble NetR5 Reference Station is a multi-channel, multi-frequency GNSS (Global Navigation Satellite System) receiver designed for use as a stand-alone reference station or as part of a GNSS infrastructure solution. Trimble R-Track technology in the NetR5 receiver supports the modernized GPS L2C and L5 signals as well as GLONASS L1/L2 signals.

2.4 *Field Survey Procedures and Analysis*

Dewberry field surveyors used Trimble R-10 GNSS receivers, which is a geodetic quality dual frequency GPS receiver, to collect data at each surveyed location.

All locations were occupied once with approximately 50% of the locations being re-observed. All re-observations matched the initially derived station positions within the allowable tolerance of ± 5cm or within the 95% confidence level. Each occupation which utilized the VRS network was occupied for approximately three (3) minutes in duration and measured to 180 epochs.

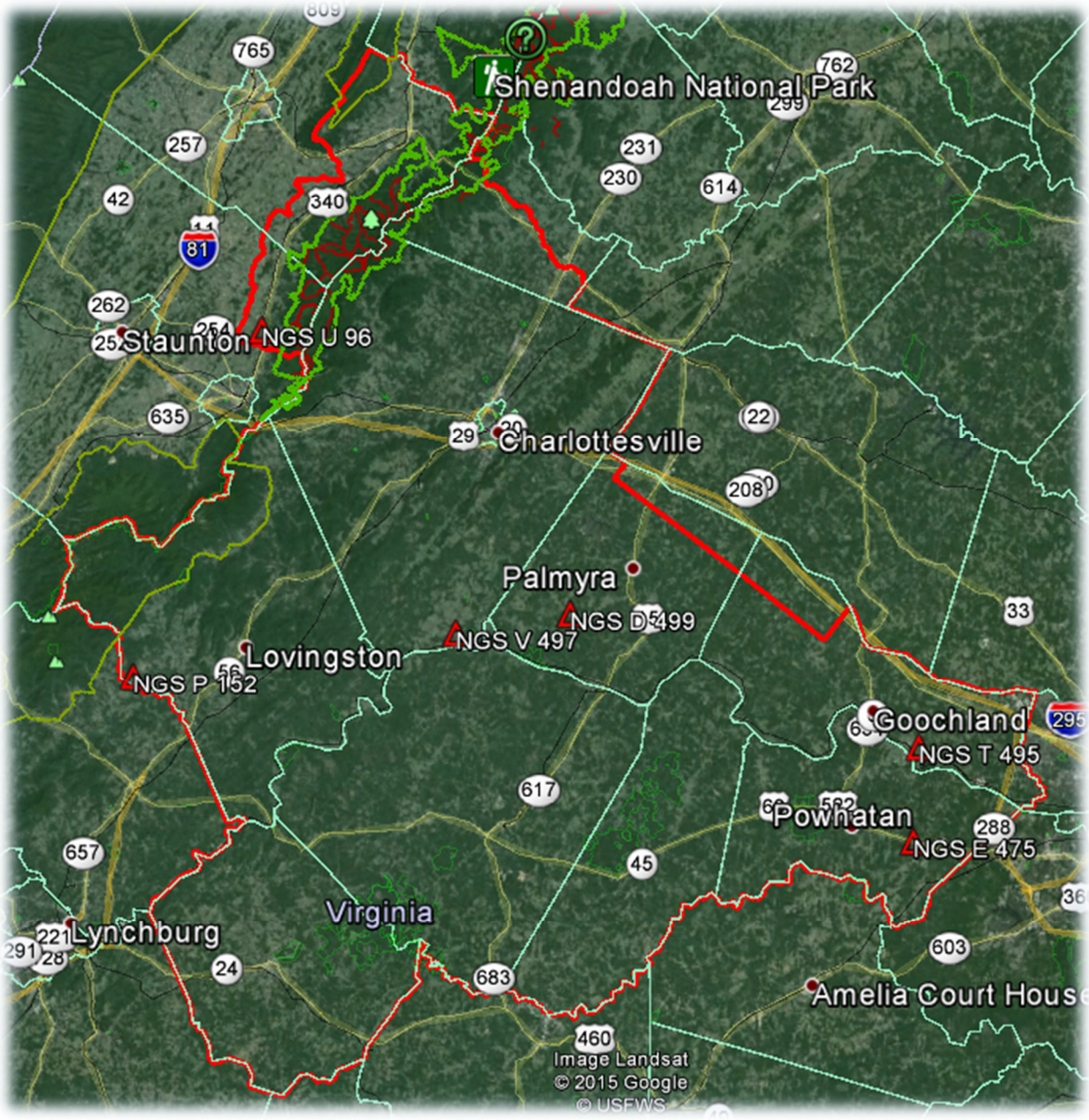
Each occupation which utilized OPUS (if used) was occupied between 20 and 30 minutes.

Field GPS observations are detailed on the "Control Point Documentation Reports" submitted as part of this report.

Six (6) existing NGS monument listed in the NSRS database were located as an additional QA/QC method to check the accuracy of the VRS network as well as being the primary project control monuments designated as GV3441, GW1042, HW0695, GW2026, GW2018 and GV3585. The results are as follows:

	As Surveyed (F)			Published (F)			Differences (F)		
NGS PT. ID	Northing(F)	Easting(F)	Elev.(F)	Northing(F)	Easting(F)	Elev. (F)	Δ N	Δ E	Δ Elev.
NGS P 152	3786628.73	11324591.91	785.68	3786628.52	11324591.8	786.06	0.21	0.09	0.38
NGS U96	6739308.75	11382064.71	1251.55	6739308.70	11382064.6	1251.58	0.05	0.07	0.03
NGS V 497	3807284.61	11471043.56	405.94	3807284.61	11471043.5	406.25	0.00	0.03	0.31
NGS-D499	3816354.60	11522955.93	502.13	3816354.67	11522955.9	502.19	0.07	0.04	0.06
NGS E475	3714345.14	11679534.21	409.11	3714345.23	11679534.3	409.00	0.10	0.08	0.11
NGS T495	3756890.88	11681749.28	276.04	3756890.79	11681749.3	276.18	0.09	0.03	0.14

The above results indicate that the VRS network is providing positional values within the 5cm parameters for this survey.



NGS Monuments

2.5 *Adjustment*

The survey data was collected using Virtual Reference Stations (VRS) methodology within a Virtual Reference System (VRS).

The system is designed to provide a true Network RTK performance, the RTKNet software enables high-accuracy positioning in real time across a geographic region. The RTKNet software package uses real-time data streams from the KEYNET system user and generates correction models for high-accuracy RTK GPS corrections throughout the network. Therefore, corrections were applied to the points as they were being collected, thus negating the need for a post process adjustment.

2.6 *Data Processing Procedures*

After field data is collected the information is downloaded from the data collectors into the office software. The Software program used is called Trimble Business Center.

Downloaded data is run through the TBC program to obtain the following reports; points report, point comparison report and a point detail report. The reports are reviewed for point accuracy and precision.

After review of the point data an “ASCII” or “txt” file which is the industry standard is created. Point files are loaded into our CADD program (Carlson Survey 2014) to make a visual check of the point data (Pt. #, Coordinates, Elev. and Description). The data can now be imported into the final product.

3. *FINAL COORDINATES*

POINT ID	NORTHING (FT)	EASTING (FT)	ELEV. (FT)
GCP			
GCP-1	13984212.583	2319651.006	952.861
GCP-2	13939749.957	2286335.179	1162.419
GCP-3	13941834.261	2333668.892	1355.119
GCP-4	13917592.072	2368845.049	625.706
GCP-5	13908984.456	2272125.480	1144.807
GCP-6	13876312.387	2261394.207	1215.719
GCP-7	13868048.789	2332209.804	601.764
GCP-8	13879204.089	2353214.316	616.419
GCP-9	13858513.517	2374908.281	600.516
GCP-10	13861318.741	2410046.764	478.388
GCP-11	13833068.365	2426700.811	420.700
GCP-12	13835297.971	2364024.081	498.079
GCP-13	13813683.472	2359230.618	454.192
GCP-14	13800911.361	2263093.426	725.524
GCP-15	13776867.242	2308042.769	647.774
GCP-16	13781791.058	2414873.729	352.858
GCP-17	13743483.557	2458103.167	355.335
GCP-18	13693166.204	2310633.567	407.366
GCP-19	13742699.046	2334036.247	562.399
GCP-20	13779196.456	2263783.483	688.542
GCP-21	13762690.729	2173849.705	2971.126
GCP-22	13740304.896	2236477.847	958.307
GCP-23	13725800.427	2256333.735	808.823
GCP-24	13700256.389	2212073.664	723.736
GCP-25	13751959.157	2386047.056	510.610
GCP-26	13721636.713	2367137.519	437.971
GCP-27	13700255.651	2358707.996	509.848
GCP-28	13676656.384	2361781.845	475.177
GCP-29	13656530.646	2364635.141	519.130
GCP-30	13626016.159	2358669.344	664.057
GCP-31	13620884.544	2239923.779	572.784
GCP-32	13658173.358	2303369.038	752.784
GCP-33	13631911.555	2318648.376	594.715
GCP-34	13598085.953	2276741.221	839.735

GCP-35	**13584615.049**	**2284021.660**	**735.477**
GCP-36	**13554368.361**	**2245110.009**	**771.094**
GCP-37	**13515516.396**	**2278673.873**	**746.399**
GCP-38	**13538325.962**	**2315388.237**	**678.187**
GCP-39	**13560971.680**	**2385079.594**	**429.141**
GCP-40	**13587791.836**	**2394300.094**	**399.633**
GCP-41	**13708339.557**	**2437007.405**	**388.921**
GCP-42	**13646160.410**	**2423725.183**	**300.284**
GCP-43	**13690372.685**	**2427450.403**	**389.648**
GCP-44	**13628234.484**	**2440372.821**	**447.289**
GCP-45	**13695446.942**	**2541411.674**	**271.498**
GCP-46	**13621473.971**	**2464665.442**	**368.653**
GCP-47	**13663896.503**	**2516196.879**	**307.645**
GCP-48	**13693177.824**	**2483879.894**	**191.849**
GCP-49	**13726006.734**	**2544458.723**	**359.290**
GCP-50	**13637884.435**	**2534750.214**	**340.646**
GCP-51	**13623003.500**	**2566841.911**	**339.726**
GCP-52	**13634904.712**	**2585896.054**	**318.005**
GCP-53	**13653355.332**	**2607752.103**	**153.495**
GCP-54	**13677811.701**	**2611455.468**	**160.450**
GCP-55	**13704199.430**	**2615290.291**	**266.846**
GCP-56	**13709523.974**	**2592572.010**	**337.045**
GCP-57	**13713512.384**	**2585718.032**	**313.954**
GCP-58	**13709063.376**	**2563926.444**	**289.929**
GCP-59	**13669542.064**	**2556954.910**	**282.050**
GCP-60	**13672577.458**	**2588800.439**	**179.930**
GCP-61	**13723230.102**	**2431786.698**	**374.464**
GCP-62	**13733829.266**	**2289208.336**	**490.536**

4. *GPS OBSERVATIONS*

POINT ID	OBSERV. DATE	JULIAN DATE	TIME OF DAY	RE-OBSERV. DATE	RE-OBSERV. TIME
GCP					
GCP-1	12/13/2015	347	14:57	12/3/2015	21:36
GCP-2	12/3/2015	337	16:07	12/3/2015	20:18
GCP-3	12/3/2015	337	13:39	N/A	N/A
GCP-4	12/4/2015	338	13:39	12/5/2015	5:13
GCP-5	12/3/2015	337	17:15	12/3/2015	22:28
GCP-6	12/3/2015	337	17:52	12/3/2015	22:43
GCP-7	12/4/2015	338	16:25	12/5/2015	6:18
GCP-8	12/4/2015	338	15:46	N/A	N/A
GCP-9	12/4/2015	338	12:16	12/4/2015	22:47
GCP-10	12/4/2015	338	11:07	12/4/2015	21:59
GCP-11	12/4/2015	338	10:19	12/4/2015	21:19
GCP-12	12/4/2015	338	7:47	12/4/2015	18:48
GCP-13	12/4/2015	338	8:27	12/4/2015	19:41
GCP-14	12/5/2015	339	9:29	12/5/2015	13:13
GCP-15	12/1/2015	335	9:07	12/3/2015	8:26
GCP-16	12/2/2015	336	21:16	N/A	N/A
GCP-17	12/2/2015	336	17:10	12/4/2015	7:35
GCP-18	12/3/2015	337	14:14	N/A	N/A
GCP-19	11/30/2015	334	22:18	12/3/2015	6:45
GCP-20	12/3/2015	337	9:36	N/A	N/A
GCP-21	11/21/2015	325	13:40	N/A	N/A
GCP-22	12/3/2015	337	11:04	N/A	N/A
GCP-23	12/1/2015	335	11:58	12/1/2015	20:21
GCP-24	12/1/2015	335	14:42	12/3/2015	6:18
GCP-25	12/2/2015	336	20:19	N/A	N/A
GCP-26	12/2/2015	336	12:15	N/A	N/A
GCP-27	12/2/2015	336	13:49	N/A	N/A
GCP-28	11/22/2015	326	16:25	N/A	N/A
GCP-29	11/22/2015	326	16:45	N/A	N/A
GCP-30	11/22/2015	326	12:07	N/A	N/A
GCP-31	11/21/2015	325	8:43	11/21/2015	18:33
GCP-32	11/21/2015	325	13:37	N/A	N/A
GCP-33	11/21/2015	325	15:32	11/21/2015	20:38

GCP-34	11/20/2015	324	16:32	N/A	N/A
GCP-35	11/20/2015	324	15:55	N/A	N/A
GCP-36	11/20/2015	324	8:04	11/20/2015	19:22
GCP-37	11/20/2015	324	10:21	11/20/2015	19:54
GCP-38	11/20/2015	324	12:11	11/20/2015	20:45
GCP-39	11/22/2015	326	13:20	N/A	N/A
GCP-40	11/22/2015	326	12:30	11/22/2015	14:13
GCP-41	11/22/2015	326	15:49	12/4/2015	6:25
GCP-42	11/21/2015	325	10:33	N/A	N/A
GCP-43	11/22/2015	326	15:15	N/A	N/A
GCP-44	11/21/2015	325	15:40	11/21/2015	19:53
GCP-45	11/20/2015	324	15:20	N/A	N/A
GCP-46	11/22/2015	326	9:43	N/A	N/A
GCP-47	11/21/2015	325	7:45	11/21/2015	17:52
GCP-48	11/20/2015	324	13:55	N/A	N/A
GCP-49	11/20/2015	324	10:40	11/20/2015	20:02
GCP-50	11/22/2015	326	8:13	N/A	N/A
GCP-51	11/22/2015	326	7:07	N/A	N/A
GCP-52	11/22/2015	326	6:28	N/A	N/A
GCP-53	11/22/2015	326	6:12	N/A	N/A
GCP-54	11/21/2015	325	6:05	N/A	N/A
GCP-55	11/20/2015	324	7:20	11/20/2015	17:31
GCP-56	11/20/2015	324	8:25	11/20/2015	18:23
GCP-57	11/20/2015	324	8:40	11/20/2015	18:41
GCP-58	11/20/2015	324	10:02	11/20/2015	19:22
GCP-59	11/21/2015	325	7:15	N/A	N/A
GCP-60	11/20/2015	324	16:35	11/20/2015	20:45
GCP-61	12/2/2015	336	15:28	12/4/2015	6:36
GCP-62	12/1/2015	335	10:25	12/1/2015	20:02

5. *POINT COMPARISON*

LiDAR QA/QC				
POINT ID	POINT CK	DELTA NORTH (F)	DELTA EAST (F)	VERT. DIFF (F)
GCP				
GCP-1	GCP-1 CK	0.01	0.02	0.08
GCP-2	GCP-2 CK	0.02	0.00	0.04
GCP-4	GCP-4 CK	0.01	0.01	0.01
GCP-5	GCP-5 CK	0.00	0.01	0.00
GCP-6	GCP-6 CK	0.02	0.00	0.00
GCP-7	GCP-7 CK	0.01	0.01	0.08
GCP-9	GCP-9 CK	0.01	0.01	0.03
GCP-10	GCP-10 CK	0.00	0.01	0.04
GCP-11	GCP-11 CK	0.01	0.03	0.05
GCP-12	GCP-12 CK	0.01	0.00	0.01
GCP-13	GCP-13 CK	0.00	0.01	0.02
GCP-14	GCP-14 CK	0.01	0.01	0.01
GCP-15	GCP-15 CK	0.06	0.02	0.03
GCP-17	GCP-17 CK	0.00	0.06	0.05
GCP-19	GCP-19 CK	0.01	0.01	0.08
GCP-23	GCP-23 CK	0.01	0.01	0.00
GCP-24	GCP-24 CK	0.02	0.00	0.00
GCP-31	GCP-31 CK	0.04	0.00	0.05
GCP-33	GCP-33 CK	0.02	0.00	0.03
GCP-36	GCP-36 CK	0.01	0.01	0.04
GCP-37	GCP-37 CK	0.00	0.02	0.07
GCP-38	GCP-38 CK	0.04	0.02	0.03
GCP-40	GCP-40 CK	0.02	0.28	0.41
GCP-41	GCP-41 CK	0.01	0.01	0.08
GCP-44	GCP-44 CK	0.01	0.00	0.00
GCP-47	GCP-47 CK	0.02	0.01	0.00
GCP-49	GCP-49 CK	0.02	0.01	0.03
GCP-55	GCP-55 CK	0.01	0.02	0.01
GCP-56	GCP-56 CK	0.01	0.01	0.08
GCP-57	GCP-57 CK	0.02	0.00	0.02
GCP-58	GCP-58 CK	0.02	0.02	0.08
GCP-60	GCP-60 CK	0.03	0.04	0.08
GCP-61	GCP-61 CK	0.03	0.03	0.02