

Check Point Survey Report

Prepared for:
Everglades National Park LiDAR

United States Geological Survey (USGS)
USGS Contract: G16PC00020
Task Order Number: G16PD01224



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TABLE OF CONTENTS

1.	Introduction	
1.1	Project Summary.....	3
1.2	Point of Contact.....	3
1.3	Project Area	4-6
2.	Project Details	
2.1	Survey Equipment.....	7
2.2	Survey Point Details.....	7
2.3	Network Design.....	7
2.4	Field Survey Procedures and Analysis.....	8-9
2.5	Adjustment.....	10
2.6	Data Processing Procedures.....	10
3.	Final Coordinates.....	11-15
4.	Point Comparison Report.....	16-18
5.	Survey Notes.....	19
6.	Legend.....	19
7.	Surveyor’s Certification.....	19
8.	Deliverables.....	Sent via Electronic Transfer
	Including:	
	a) In-field photographs for each surveyed point	
	b) Ground Control Point documentation report for each surveyed point	
	c) Documentation for the NGS control points used	

1. INTRODUCTION

1.1 Project Summary

Dewberry Consultants LLC is under contract to the United States Geological Survey (USGS) to provide a check point survey in the Everglades National Park located in South Florida. This survey will be used to evaluate the vertical accuracy of the bare-earth terrain derived from LiDAR. The project area consists of approximately 3,136 square kilometers (1,211 square miles). The field work for the check points was conducted from March 21, 2017 – April 03, 2017.

Published National Geodetic Survey (NGS) control points were surveyed to verify the accuracy of the equipment and survey data. The results are shown in Section 2.4 of this report.

To verify that the check points meet the 5-cm at 95% confidence level approximately 50% of the points were re-observed and their corresponding coordinate differences are shown in Section 4 of this report.

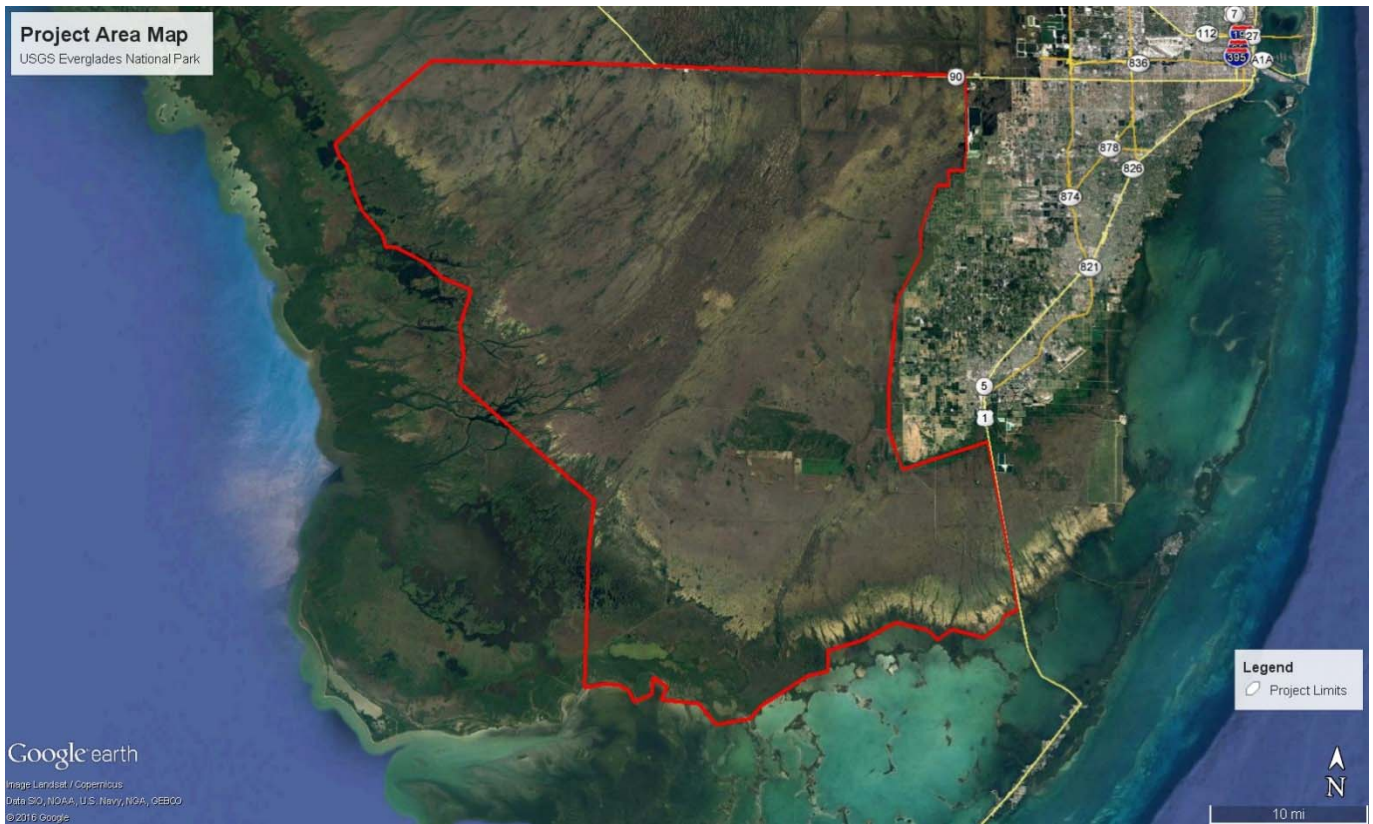
A map showing the overall project area is shown in section 1.3. All coordinates are in meters. The horizontal coordinates are referenced to the Universal Transverse Mercator (UTM), Zone 17N. The vertical coordinates are referenced to the North American Vertical Datum of 1988 (NAVD88) using Geoid model 2012B (Geoid12B).

1.2 Point of Contact

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

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1.3 Project Area

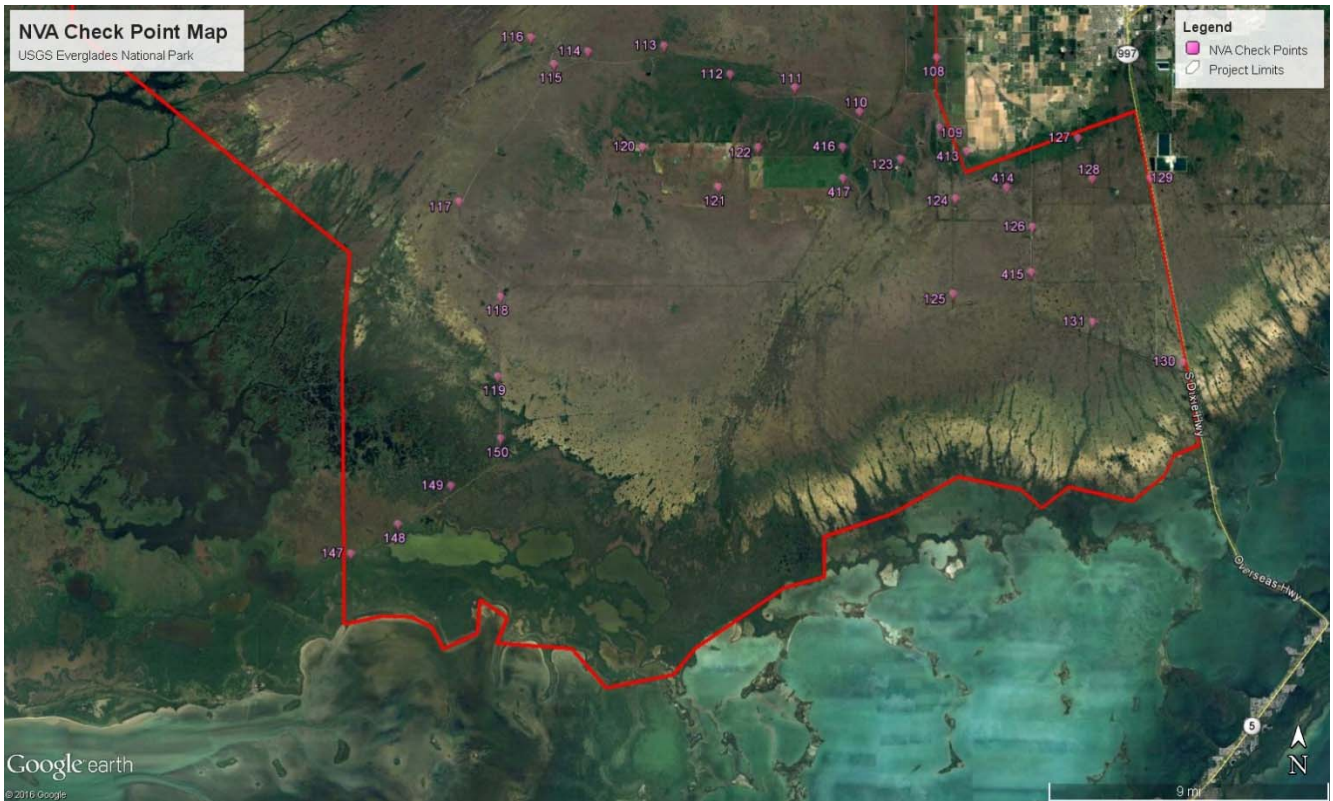


Overall Project Area Map

1.3 Project Area (continued)



NVA Check Point Map (North)

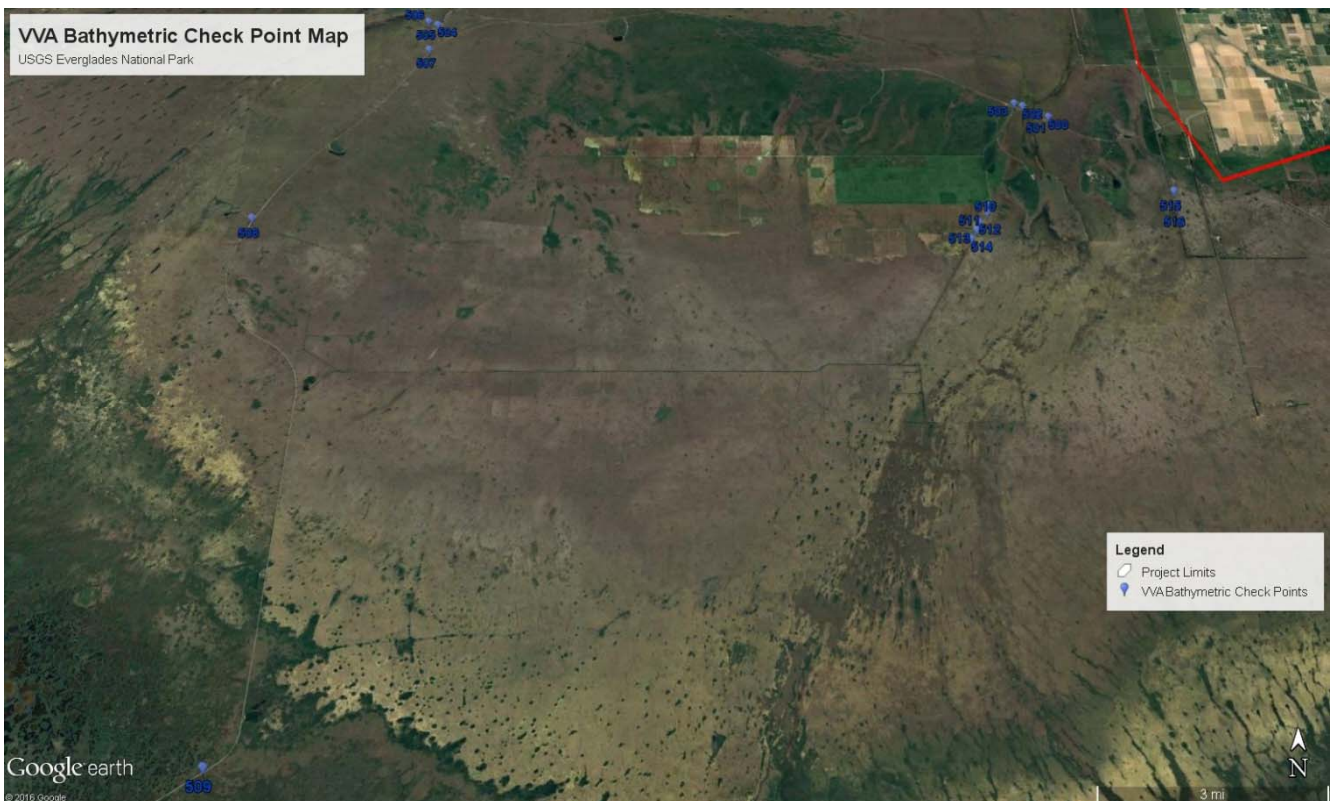


NVA Check Point Map (South)

1.3 Project Area (continued)



VVA Check Point Map



VVA Bathymetric Check Point Map

2. PROJECT DETAILS

2.1 Survey Equipment

To perform the survey observations, a Spectra Precision SP80 GPS receiver was used. A two-meter fixed height GPS pole and bi-pod legs were used to mount and stabilize the receiver. A Spectra Precision Ranger 3 Data-Collector was used to read and store the data. The SP80 GPS unit is a geodetic- quality dual-frequency GPS receiver.

2.2 Survey Point Details

The LiDAR check points were well distributed throughout the project area by pre-selecting them in the office using aerial imagery. The American Society for Photogrammetry and Remote Sensing (ASPRS) guidelines were followed for point selection as closely as possible by maintaining a spaced interval of 10 percent of the diagonal distance across the dataset and 20 percent of the points in each quadrant of the dataset. The National Parks Service (NPS) provided a helicopter for access to the points that were within the remote areas of the Everglades.

A sketch was made for each location and a nail & disk or 60d nail was set at a point where allowable in urban areas. Nothing was set or left behind in rural areas per NPS guidelines. The check point locations are detailed in the “Ground Control Point Documentation Report”.

Surveyed Check Point Summary	
Designation	Number
NVA Check Point	27
NVA Horizontal	35
VVA Check Point	59
VVA Bathymetric	17
Total	138

The above summary shows the classifications and number of field surveyed check points. Only 17 VVA bathymetric points were surveyed due to the dry conditions and low water levels within the project limits during the field survey.

2.3 Network Design

Two real-time kinematic (RTK) networks were used to establish and verify the accuracy of the observations. The Trimble VRS Now network was used for the first observation and the Florida Permanent Reference Network (FPRN) was used for the second observation. The GPS units connected to the networks using a cellular connection and a virtual reference station. The RTK networks provide instant access to RTK corrections utilizing a network of permanent (fixed) continuously operating reference stations. The published accuracy for the networks are less than 2cm. All recorded observations were within 5-cm of each other. These observations were averaged to produce the final coordinate value for the check points.

2.4 Field Survey Procedures

The check point locations were observed once with approximately 50% of the locations being re-observed. All re-observations matched the initially derived station position within the allowable tolerance of $\pm 5\text{cm}$ or within the 95% confidence level. Each observation was approximately 3 minutes in duration and measured to 180 epochs. The second observation was taken immediately after the first observation for this project due to the access constraints of the Everglades. The GPS observations are detailed on the “Ground Control Point Documentation Reports” submitted as part of this report.

Eleven (11) published National Geodetic Survey (NGS) control points with horizontal and vertical coordinates were observed during the survey. A map of the NGS control points surveyed is on the following page. The NGS control was used as an additional QA/QC process to check the accuracy of the observations. A NGS control point was observed at the beginning and end of each day of the survey. The surveyed average coordinates compared with the published NGS coordinates were all within the $\pm 5\text{cm}$ tolerance as shown below.

NGS PT. ID	Designation	As Surveyed (M)			Published (M)			Differences (M)		
		Northing	Easting	Elev	Northing	Easting	Elev	ΔN	ΔE	$\Delta Elev$
AC4738	J 407	2849367.056	549835.667	1.960	2849367.069	549835.673	1.953	-0.013	-0.006	0.007
AC3931	KROME	2835754.558	550443.221	4.087	2835754.536	550443.212	4.069	0.022	0.009	0.018
AC1157	DA 124 RESET	2814686.088	552574.419	1.245	2814686.090	552574.428	1.249	-0.002	-0.009	-0.004
AB2362	EG 2	2809719.727	544434.178	2.763	2809719.737	544434.172	2.777	-0.010	0.006	-0.014
AC4350	DAWAL 3	2801610.986	547765.057	1.245	2801610.985	547765.014	1.235	0.001	0.043	0.010
AB2368	L 432	2810619.984	537670.175	1.393	2810619.986	537670.169	1.382	-0.002	0.006	0.011
AB2372	Q 432	2812159.709	531779.110	1.505	2812159.713	531779.099	1.522	-0.004	0.011	-0.017
AB2374	S 432	2813179.874	528102.224	1.357	2813179.893	528102.220	1.398	-0.019	0.004	-0.041
AB2378	W 432	2811021.252	522054.873	1.008	2811021.274	522054.879	1.011	-0.022	-0.006	-0.003
AB2382	A 433	2805890.618	518368.706	0.836	2805890.645	518368.715	0.876	-0.027	-0.009	-0.040
AB2386	E 433	2800379.832	520294.307	0.658	2800379.837	520294.305	0.687	-0.005	0.002	-0.029

2.4 Field Survey Procedures and Analysis (continued)



NGS Control Map

2.5 *Adjustment*

Adjustment is not necessary for the survey data collected using the RTK GPS Trimble VRS Now Network. The system is designed to provide final processed coordinates, enabling high-accuracy positioning in real time across a geographic region. Trimble VRS Now uses real-time data streams from the system user and generates correction models for high-accuracy RTK GPS corrections throughout the network. These corrections are applied to the points as they are being collected, 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 Trimble Business Center (TBC). Downloaded data is processed through TBC to obtain the following reports: points list, point derivations and a vector spreadsheet. The reports are reviewed for point accuracy and precision.

After review of the point data an “ASCII” or “txt” file is created. Point files are loaded into AutoCAD Civil 3D to check the point data (Point #, Northing, Easting, Elevation, Description). The data is then organized using spreadsheets and imported into the final products.

3. FINAL COORDINATES

USGS EVERGLADES LiDAR CHECK POINTS			
NVA			
POINT NUMBER	NORTHING (UTM17 Meters)	EASTING (UTM17 Meters)	ELEVATION (Meters)
100	2836710.72	543079.60	3.39
101	2837248.06	547314.00	1.61
102	2835637.59	546793.71	1.61
103	2832407.96	545750.18	2.17
104	2832427.14	542664.06	2.34
106	2822474.29	542756.18	3.20
107	2817792.76	542810.29	2.86
108	2812729.45	542866.73	1.82
118	2800382.67	520306.63	0.88
120	2808089.38	527594.24	0.34
122	2808098.15	533607.06	1.29
123	2807498.29	541002.77	0.89
124	2805488.59	543836.92	1.02
125	2800572.49	543714.58	1.19
126	2804003.62	547816.23	2.23
128	2806522.06	550898.08	1.09
129	2806554.04	553937.03	1.30
130	2797122.75	555680.23	0.66
131	2799162.55	550957.36	0.54
148	2788702.56	515034.47	0.86
150	2793107.85	520348.95	0.66
158	2849373.80	530381.44	3.25
161	2837818.88	523434.37	1.87
413	2807928.59	544411.24	2.23
414	2806069.55	546485.02	2.48
415	2801713.16	547771.68	2.10
417	2806509.32	538007.78	0.82

3. FINAL COORDINATES (CONTINUED)

USGS EVERGLADES LiDAR CHECK POINTS			
NVA Horizontal			
POINT NUMBER	NORTHING (UTM17 Meters)	EASTING (UTM17 Meters)	ELEVATION (Meters)
105	2827526.84	542686.17	2.29
109	2809128.92	543026.28	2.26
110	2809933.28	538851.84	1.32
111	2811173.34	535509.58	1.65
112	2811832.53	532162.45	1.67
113	2813307.20	528735.23	1.68
114	2813000.11	524791.75	1.27
115	2812348.82	523030.73	1.35
116	2813724.04	521825.29	1.08
117	2805267.92	518134.55	0.98
119	2796284.38	520171.16	0.95
121	2806039.42	531554.39	1.32
127	2808610.68	550179.27	0.81
132	2849179.28	514356.18	2.75
133	2849334.30	517304.70	4.19
134	2849313.90	519410.49	4.00
135	2849187.80	520397.03	2.97
136	2849303.61	522567.26	3.01
137	2848795.89	523518.88	3.02
143	2848776.82	506861.66	2.13
144	2849026.74	496434.48	2.45
145	2849055.65	500665.49	2.05
146	2844988.41	495246.92	0.80
147	2787190.34	512625.15	0.91
149	2790677.64	517775.76	0.95
151	2849277.21	544035.94	2.61
152	2849319.66	549985.73	2.93
153	2849354.40	525217.98	3.43
154	2849358.58	526026.25	3.37
155	2849370.06	527568.52	3.35
156	2849370.46	528720.25	3.37
157	2849351.20	529581.79	3.85
159	2849371.26	531651.62	3.77
160	2849294.57	532739.34	3.48
416	2808117.98	537995.12	1.81

3. FINAL COORDINATES (CONTINUED)

USGS EVERGLADES LiDAR CHECK POINTS			
VVA			
POINT NUMBER	NORTHING (UTM17 Meters)	EASTING (UTM17 Meters)	ELEVATION (Meters)
138	2843726.49	512703.24	1.55
139	2844025.51	517995.59	1.77
140	2843803.26	521738.09	1.64
141	2838598.56	509960.51	0.80
142	2838695.40	514924.28	1.28
200	2840111.18	543237.47	1.38
201	2840322.08	550231.76	1.69
202	2833878.33	539299.42	1.42
203	2831173.02	534056.35	1.21
204	2826333.02	532428.57	1.19
205	2826656.37	538753.23	1.37
206	2820200.09	538665.87	1.06
207	2819992.30	534162.99	1.21
208	2819935.58	529540.56	0.94
209	2819564.13	523092.00	0.33
210	2815534.59	538659.45	1.17
211	2808392.49	520050.15	0.26
212	2800464.23	525060.42	0.05
213	2800873.87	529435.81	0.26
214	2800656.34	534339.09	-0.09
215	2800661.43	538619.37	0.12
216	2796730.63	548069.55	-0.38
217	2795917.09	543208.97	-0.38
218	2794739.96	537220.33	-0.32
219	2794966.41	531952.19	-0.46
220	2790382.64	529450.00	-0.45
221	2794754.58	524870.16	-0.37
222	2838820.22	520378.16	1.39
223	2833812.84	508007.55	0.28
224	2834083.57	514368.83	1.00
225	2833409.75	518816.48	1.04
226	2828624.58	503114.79	-0.16
227	2828621.43	509064.10	0.39
228	2828393.11	515997.20	0.76
229	2824548.14	499924.98	-0.18
230	2824597.49	508657.90	0.15

3. FINAL COORDINATES (CONTINUED)

USGS EVERGLADES LiDAR CHECK POINTS			
VVA			
POINT NUMBER	NORTHING (UTM17 Meters)	EASTING (UTM17 Meters)	ELEVATION (Meters)
231	2824466.81	515466.94	0.43
232	2820918.29	505811.96	-0.19
233	2844273.37	505010.51	1.21
234	2838283.07	503130.45	0.41
235	2839248.01	495637.56	0.09
236	2840072.18	489696.60	-0.30
237	2834814.67	495068.28	-0.29
238	2787735.45	513115.32	-0.16
239	2792098.23	520415.85	-0.41
240	2790559.95	537823.67	-0.56
241	2794082.51	551893.47	-0.28
242	2846853.29	537786.18	1.44
243	2845977.71	543006.74	1.45
244	2828390.52	497670.07	-0.15
245	2840655.31	484791.68	-0.34
246	2841735.42	524886.57	1.42
247	2840691.66	531701.48	1.43
248	2834496.69	523019.87	1.14
249	2835048.15	532535.43	1.40
250	2828596.78	520898.53	0.78
251	2827894.78	527135.74	0.98
252	2817421.75	512772.22	-0.04
253	2808496.61	511048.18	-0.25

3. FINAL COORDINATES (CONTINUED)

USGS EVERGLADES LiDAR CHECK POINTS			
VVA Bathymetric			
POINT NUMBER	NORTHING (UTM17 Meters)	EASTING (UTM17 Meters)	ELEVATION (Meters)
500	2809333.18	539946.13	-0.10
501	2809443.74	539720.08	-0.42
502	2809708.19	539281.65	-0.15
503	2809809.73	539060.76	-0.14
504	2812703.65	522668.67	0.00
505	2812835.41	522392.07	-0.06
506	2813105.88	522042.29	-0.18
507	2811759.16	522506.89	-0.17
508	2805881.61	518380.97	-0.32
509	2791919.96	519662.32	-0.46
510	2806302.85	537914.17	-0.12
511	2806091.93	537843.54	-0.05
512	2805784.18	537595.32	-0.19
513	2805542.11	537508.60	-0.15
514	2805257.62	537325.00	-0.63
515	2806822.56	542942.85	-0.14
516	2806294.07	542940.40	-0.25

4. POINT COMPARISON REPORT

Check Point QA/QC				
POINT ID	CHECK POINT ID	Δ NORTH	Δ EAST	Δ ELEV
NVA-100	NVA_CHK-100	0.01	-0.01	-0.01
NVA-101	NVA_CHK-101	-0.01	0.00	-0.01
NVA-102	NVA_CHK-102	-0.01	0.00	-0.05
NVA-103	NVA_CHK-103	0.01	0.01	0.02
NVA-104	NVA_CHK-104	-0.01	-0.01	-0.01
NVA-106	NVA_CHK-106	0.01	0.00	0.04
NVA-107	NVA_CHK-107	0.00	-0.01	0.02
NVA-108	NVA_CHK-108	-0.01	-0.01	-0.02
NVA-118	NVA_CHK-118	0.01	-0.01	-0.04
NVA-120	NVA_CHK-120	0.00	0.00	-0.03
NVA-122	NVA_CHK-122	0.00	0.01	-0.01
NVA-123	NVA_CHK-123	-0.01	-0.01	0.02
NVA-124	NVA_CHK-124	-0.02	0.00	0.02
NVA-125	NVA_CHK-125	-0.03	0.01	-0.01
NVA-126	NVA_CHK-126	-0.02	0.00	-0.05
NVA-128	NVA_CHK-128	0.00	-0.01	-0.04
NVA-129	NVA_CHK-129	-0.02	-0.02	0.02
NVA-130	NVA_CHK-130	0.00	-0.01	-0.01
NVA-131	NVA_CHK-131	-0.01	-0.02	-0.01
NVA-148	NVA_CHK-148	-0.01	-0.01	-0.02
NVA-150	NVA_CHK-150	0.01	-0.01	-0.01
NVA-158	NVA_CHK-158	0.01	0.00	0.00
NVA-161	NVA_CHK-161	-0.01	0.01	0.00
NVA-413	NVA_CHK-413	-0.01	0.00	-0.01
NVA-414	NVA_CHK-414	-0.01	0.00	0.01
NVA-415	NVA_CHK-415	-0.01	0.00	0.01
NVA-417	NVA_CHK-417	0.00	0.00	0.00
NVA_HOR-105	NVA_HOR_CHK-105	0.00	-0.02	0.01
NVA_HOR-109	NVA_HOR_CHK-109	-0.01	0.01	-0.03
NVA_HOR-110	NVA_HOR_CHK-110	0.00	0.00	-0.02
NVA_HOR-111	NVA_HOR_CHK-111	0.00	-0.01	-0.02
NVA_HOR-112	NVA_HOR_CHK-112	0.01	0.00	-0.04
NVA_HOR-113	NVA_HOR_CHK-113	0.01	-0.01	-0.05
NVA_HOR-114	NVA_HOR_CHK-114	0.00	-0.01	-0.02
NVA_HOR-115	NVA_HOR_CHK-115	0.02	0.01	0.04
NVA_HOR-116	NVA_HOR_CHK-116	0.01	-0.01	-0.01
NVA_HOR-117	NVA_HOR_CHK-117	0.02	0.01	-0.03
NVA_HOR-119	NVA_HOR_CHK-119	0.01	-0.01	0.00

4. POINT COMPARISON REPORT (CONTINUED)

Check Point QA/QC				
POINT ID	CHECK POINT ID	Δ NORTH	Δ EAST	Δ ELEV
NVA_HOR-121	NVA_HOR_CHK-121	0.00	0.00	-0.02
NVA_HOR-127	NVA_HOR_CHK-127	0.00	-0.01	-0.02
NVA_HOR-132	NVA_HOR_CHK-132	-0.01	0.01	0.01
NVA_HOR-133	NVA_HOR_CHK-133	0.00	0.02	-0.02
NVA_HOR-134	NVA_HOR_CHK-134	0.00	0.01	0.01
NVA_HOR-135	NVA_HOR_CHK-135	0.01	0.00	0.01
NVA_HOR-136	NVA_HOR_CHK-136	0.00	0.01	0.00
NVA_HOR-137	NVA_HOR_CHK-137	0.00	0.01	0.02
NVA_HOR-143	NVA_HOR_CHK-143	-0.01	0.01	0.02
NVA_HOR-144	NVA_HOR_CHK-144	0.01	-0.01	0.00
NVA_HOR-145	NVA_HOR_CHK-145	0.00	0.00	0.02
NVA_HOR-146	NVA_HOR_CHK-146	0.00	0.01	0.02
NVA_HOR-147	NVA_HOR_CHK-147	0.01	-0.01	-0.01
NVA_HOR-149	NVA_HOR_CHK-149	-0.01	0.00	0.00
NVA_HOR-151	NVA_HOR_CHK-151	0.00	-0.01	0.02
NVA_HOR-152	NVA_HOR_CHK-152	0.00	0.00	-0.01
NVA_HOR-153	NVA_HOR_CHK-153	-0.01	0.01	0.03
NVA_HOR-154	NVA_HOR_CHK-154	0.00	0.00	0.02
NVA_HOR-155	NVA_HOR_CHK-155	0.00	0.00	0.02
NVA_HOR-156	NVA_HOR_CHK-156	0.00	0.00	0.00
NVA_HOR-157	NVA_HOR_CHK-157	0.00	0.00	0.01
NVA_HOR-159	NVA_HOR_CHK-159	0.00	0.00	-0.01
NVA_HOR-160	NVA_HOR_CHK-160	-0.02	-0.01	0.00
NVA_HOR-416	NVA_HOR_CHK-416	0.00	-0.02	-0.03

4. POINT COMPARISON REPORT (CONTINUED)

Check Point QA/QC				
POINT ID	CHECK POINT ID	Δ NORTH	Δ EAST	Δ ELEV
VVA_BATHY-500	VVA_BATHY_CHK-500	-0.01	-0.01	0.03
VVA_BATHY-501	VVA_BATHY_CHK-501	-0.01	0.01	-0.02
VVA_BATHY-502	VVA_BATHY_CHK-502	-0.01	-0.01	-0.01
VVA_BATHY-503	VVA_BATHY_CHK-503	0.00	-0.01	-0.01
VVA_BATHY-504	VVA_BATHY_CHK-504	0.01	0.00	-0.02
VVA_BATHY-505	VVA_BATHY_CHK-505	0.00	-0.03	-0.02
VVA_BATHY-506	VVA_BATHY_CHK-506	0.00	0.00	-0.03
VVA_BATHY-507	VVA_BATHY_CHK-507	0.00	-0.02	0.01
VVA_BATHY-508	VVA_BATHY_CHK-508	0.04	-0.01	0.02
VVA_BATHY-509	VVA_BATHY_CHK-509	0.00	-0.01	0.02
VVA_BATHY-510	VVA_BATHY_CHK-510	0.00	0.00	-0.01
VVA_BATHY-511	VVA_BATHY_CHK-511	0.01	0.00	-0.02
VVA_BATHY-512	VVA_BATHY_CHK-512	0.00	0.00	-0.03
VVA_BATHY-513	VVA_BATHY_CHK-513	0.00	0.01	-0.05
VVA_BATHY-514	VVA_BATHY_CHK-514	-0.02	-0.01	-0.04
VVA_BATHY-515	VVA_BATHY_CHK-515	0.01	0.03	-0.01
VVA_BATHY-516	VVA_BATHY_CHK-516	0.02	0.00	0.00

6. SURVEY NOTES

- 1) Coordinates shown hereon are in meters and based on the Universal Transverse Mercator Coordinate System, Zone 17N.
- 2) Elevations shown hereon are in meters and based on the North American Vertical Datum of 1988.
- 3) The purpose of this survey was to obtain accurate coordinates of the NVA, VVA, and bathymetric check points within the Everglades National Park for the verification of LiDAR data.

7. LEGEND

CHK	Check
CORS	Continuously Operating Reference Station
ELEV	Elevation
FPRN	Florida Permanent Reference Network
GCP	Ground Control Point
GPS	Global Positioning System
ID	Identification
LiDAR	Light Detection and Ranging
LS	Land Surveyor
NAD	North American Datum
NAVD	North American Vertical Datum
NGS	National Geodetic Survey
NPS	National Park Service
NVA	Non-Vegetated Vertical Accuracy Point
QA/QC	Quality Assurance/Quality Control
RTK	Real Time Kinematic
RTN	Real-Time Network
SPC	State Plane Coordinate
TBC	Trimble Business Center
USGS	United States Geological Survey
UTM	Universal Transverse Mercator
VRS	Virtual Reference System
VVA	Vegetated Vertical Accuracy Point

8. SURVEYOR'S CERTIFICATION

I hereby certify this survey report meets the applicable "Standards of Practice" as set forth by the Florida Board of Professional Surveyors and Mappers in rule 5J17.050-.052, Florida Administrative Code.

06-01-2017

William D. Donley
Florida Licensed Surveyor & Mapper No. LS 5381

Date

This Survey is not valid without the signature and original raised seal of a Florida Licensed Surveyor and Mapper.