SURVEYOR'S REPORT

Specific Purpose Survey of the
United States Geological Survey
Recorder Well F-291
in
Broward County, Florida

Prepared for:

South Florida Water Management District

3301 Gun Club Road
West Palm Beach, Florida 33406
Ph. (561) 686-8800 (ext. 2978)
Fax (561) 682-0066

Prepared by:

William Donley, PSM
Florida Professional Surveyor and Mapper
License Number 5381
State of Florida

Dewberry Engineering, Inc. LB No 8011
131 West Kaley Street, Orlando, FL. 32806
Tel (321) 354-9826

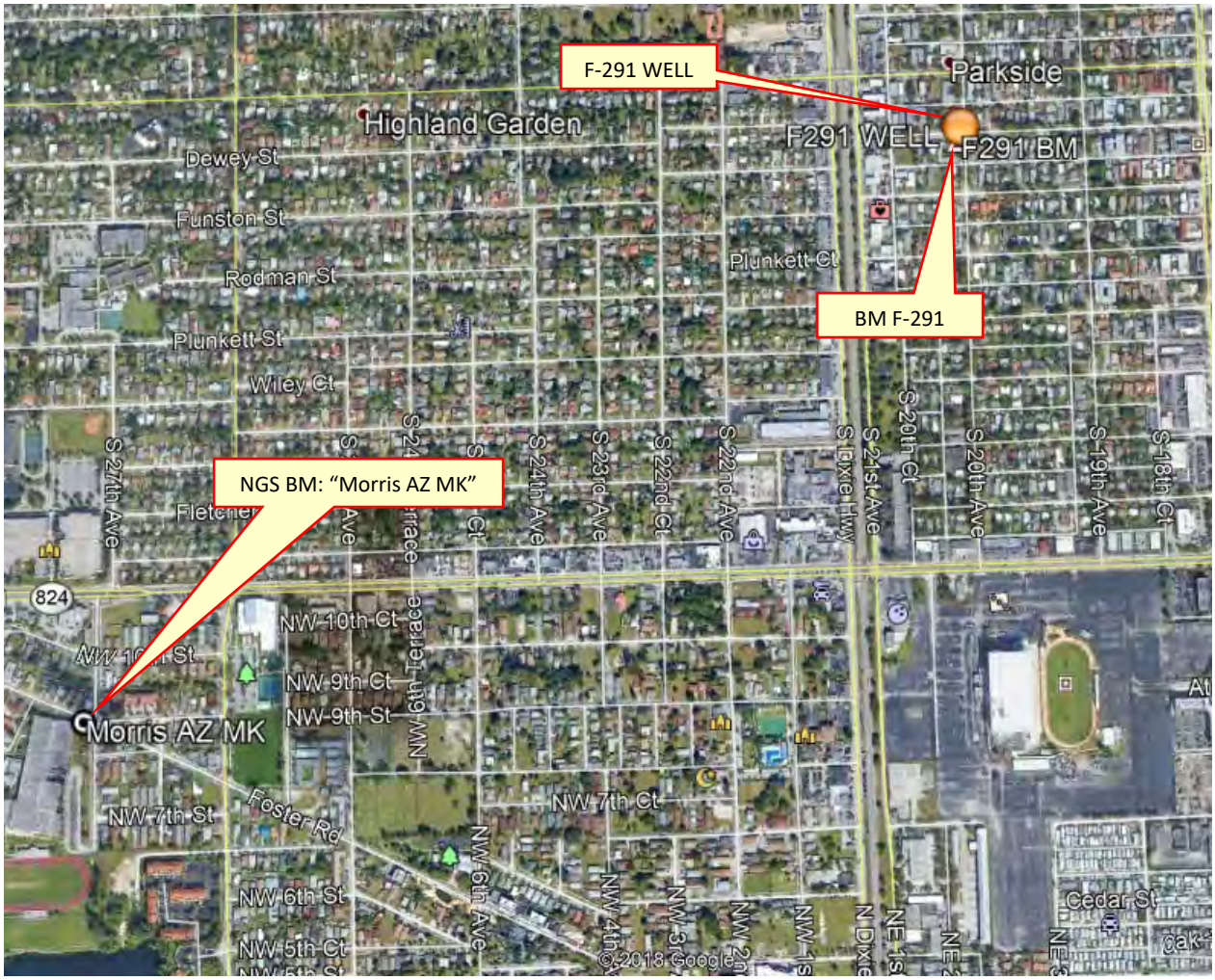
Field Date: September 19, 2019
Report Date: December 9, 2019
PO NO: 9500008146

PURPOSE

The objective of this work order is to supply NAVD 88 elevations on the site benchmark, ground elevation at the site, well monitoring point and any USGS benchmarks at the site. In addition, horizontal positions of each well and benchmark need to be provided in the North American Datum of 1983.

LOCATION OF PROJECT

The United States Geological Survey's Recorder Well **F-291** is located in Section 22, Township 51 South, Range 42 East, Broward County, Florida.



General Location (Intended Display scale is "Not to Scale")

PROJECT VERTICAL DATUM

The project vertical datum is the North American Vertical Datum (NAVD) of 1988.

To convert the NAVD 88 elevation to the National Geodetic Vertical Datum of 1929 at station **F-291 (F291 2019), add 1.60'**. These values are based on Corpscon 6.0.1 a US. Army Corps of Engineers Engineering Research and Development Center Topographic Engineering Center Alexandria, Virginia Windows-based program to convert coordinates and elevations between datum's using vertcon05.txt and vertcon05.05 files supplied by the US. Army Corps of Engineers South Atlantic Division, Jacksonville, FL.

PROJECT HORIZONTAL DATUM

All horizontal data shall be collected in and based on the North American Datum of 1983, 2011 adjustment (NAD 83/11). Horizontal coordinate control shall be established from existing National Geodetic Survey (NGS) 2nd Order control or higher in the area by using GPS, RTK GPS, network RTK GPS, or OPUS derived solutions.

LEVELING METHODS / GPS METHODS (Site Benchmark Vertical Datum)

The leveling for this project was performed in accordance with standard survey practice using conventional third order methods, techniques and equipment.

The allowable error (.02 √miles) on this project meets or exceeds third order closures as required by SFWMD for this project per executed SOW for 4600003706-WO03 and discussions with SFWMD.

A GPS base receiver was set on site BM F-291, epochs were continuously recorded on the BM from the times 9:09 AM to 1:12 PM. A second GPS receiver checked into NGS BM "MORRIS AZ MK" and the check was within tolerance. The raw data from the 4 hour session was converted to a RINEX file and uploaded to OPUS to generate a solution.

The measurements were collected using a Trimble R8 base and Trimble R8-2 Rover receivers and notes were hand written in Whidden Surveying & Mapping, Inc. Field Book W 210 Page 58, dated November 26, 2019, reduced and adjusted electronically. Additional data was manually recorded in the field book.

GPS METHODS (horizontal position of site benchmark)

Latitude and Longitude for Benchmark F-291 (F-291 2019) were established by observing a 3-minute session of GPS data on November 26, 2019 using a Trimble R-8-2 and The Florida Permanent Reference Network (FPRN). The FPRN network consists of nearly 100 Continuously Operating Reference Stations (CORS) located throughout Florida.

EQUIPMENT USED

- Trimble GPS unit R8-3 Serial #: 4639122431
- Trimble GPS unit R6-4 Serial #: 4639122445

LEVELING METHODS (Site: ground elevation-well monitoring point- USGS benchmarks)

A level loop was run from the previously established Site Benchmark F-291 (F-291 2019), through the USGS benchmarks "RM 3", "RM 1", and "RM 2", through the well monitoring point, through the ground shot (ground elevation) and back to the Site Benchmark. The measurements were collected using an Automatic Level and were hand written in Dewberry Engineering, Inc. Field Book S.F.W.M.D. #1, Pages 11-14, dated September 19, 2019. Additional data was manually recorded.

GPS METHODS (horizontal position of Well F-291 monitoring point & USGS Benchmarks)

Latitude and Longitude for Well F-291 monitoring point (Top of screw at well opening) and USGS RM 3 (Nail/disc in asphalt), USGS RM 1 (Nail/disc in asphalt), and USGS RM 2 (SW corner of concrete slab) were established by observing a 3-minute session of GPS data on September 19, 2019 using a Spectra SP-80 and The Florida Permanent Reference Network (FPRN). The FPRN network consists of nearly 100 Continuously Operating Reference Stations (CORS) located throughout Florida.

EQUIPMENT USED

- Spectra SP-80 Rover Serial #: 1165
- Topcon AT-G2 Serial #: 1439

VERTICAL CONTROL POINT

The Vertical Control point utilized and set as part of this survey is the:

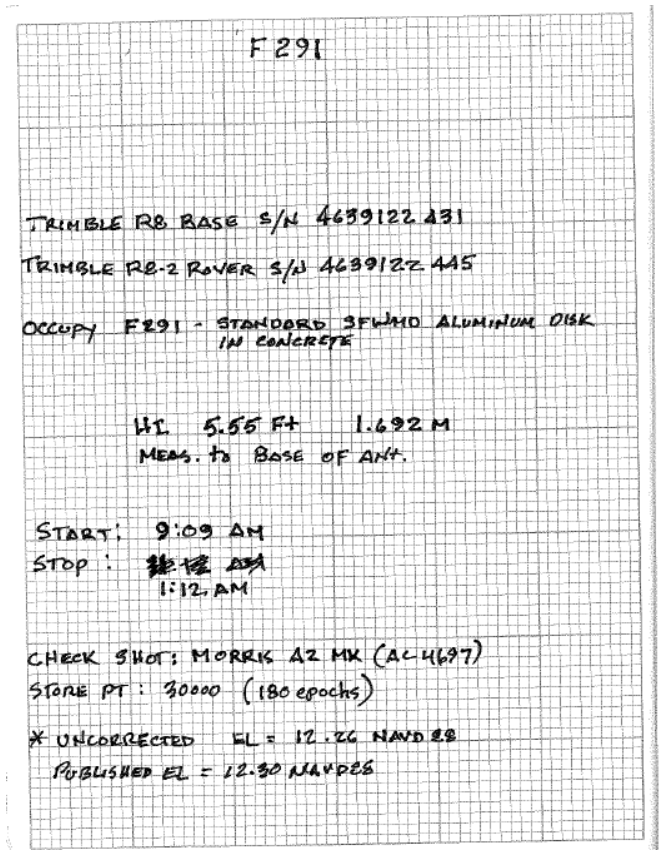
NGS Benchmark "MORRIS AZ MK" (AC4697)						
25° 59' 39.72" (N)	80° 09' 40.12" (W)	Published	12.30 ft.	(NAVD88)	3.75 m	Published
						

1.1 MI WESTERLY ALONG PEMBROKE ROAD FROM THE INTERSECTION OF U.S. HWY 1 IN HALLANDALE, THENCE 0.1 MI SOUTHERLY ALONG NW 9TH AVENUE, 62.3 FT WEST OF THE AVE CENTERLINE, 23.3 FT SW OF AND LEVEL WITH THE CENTERLINE OF FOSTER RD, 21 FT WEST OF UTILITY POLE #87570087906, 3.3 FT NORTH OF A WITNESS POST, 3.3 FT SOUTH OF THE NORTH EDGE OF A SIDEWALK, AND THE MONUMENT IS FLUSH WITH AND SURROUNDED BY A SIDEWALK.

NGS BENCHMARK DISK, SET IN CONCRETE SIDEWALK NEXT TO FENCELINE
STAMPING: NGS AZIMUTH MARK MORRIS 1977

BM: F-291 (Existing on site benchmark)						
26° 00'10.75" (N)	80° 08' 48.75" (W)		7.60 ft.	(NAVD88)	2.32 m	Level run
NAD_83(2011)			9.198 ft.	(NGVD29)	2.80 m	Converted
				1.60 ft. (conversion factor)		Corpscon 6.0.1
			STATION IS A S.F.W.M.D. BM STAMPED "F-291 2019" SET IN GRASS AREA IN BETWEEN CONCRETE SIDEWALK AND EDGE OF PAVEMENT LOCATED: SW CORNER OF INTERSECTIONS DEWEY ST AND S 20TH AVENUE			

Field Book W210, Page 58



F 291

TRIMBLE R8 BASE S/N 4639122431

TRIMBLE R8-2 ROVER S/N 4639122445

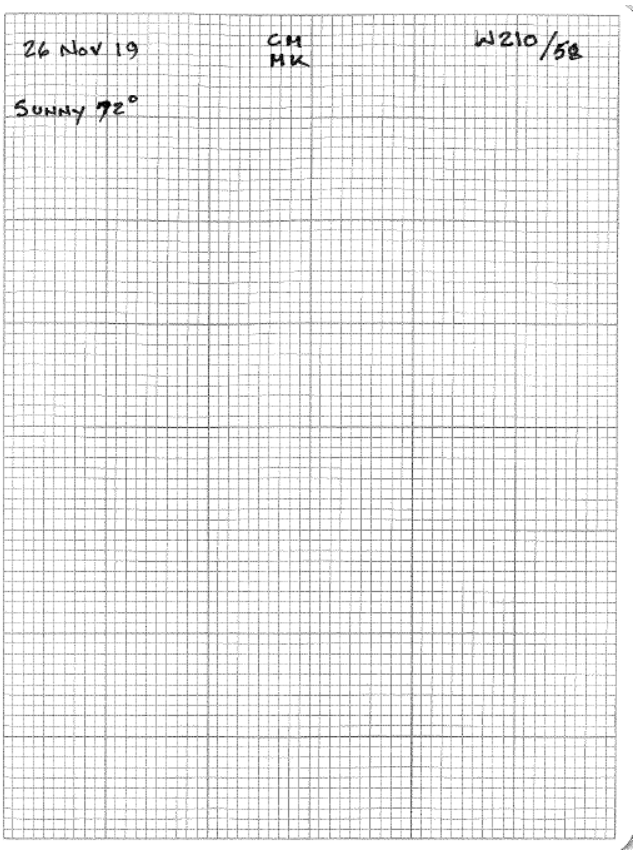
OCCUPY F291 - STANDARD SFWMD ALUMINUM DISK IN CONCRETE

HI 5.55 Ft 1.692 M
MEAS. to BASE OF ANT.

START: 9:09 AM
STOP : 11:12 AM

CHECK SHOT: MORRIS A2 MK (AC4697)
STORE PT : 30000 (180 epochs)

* UNCORRECTED EL = 12.26 NAVD88
PUBLISHED EL = 12.30 NAVD88

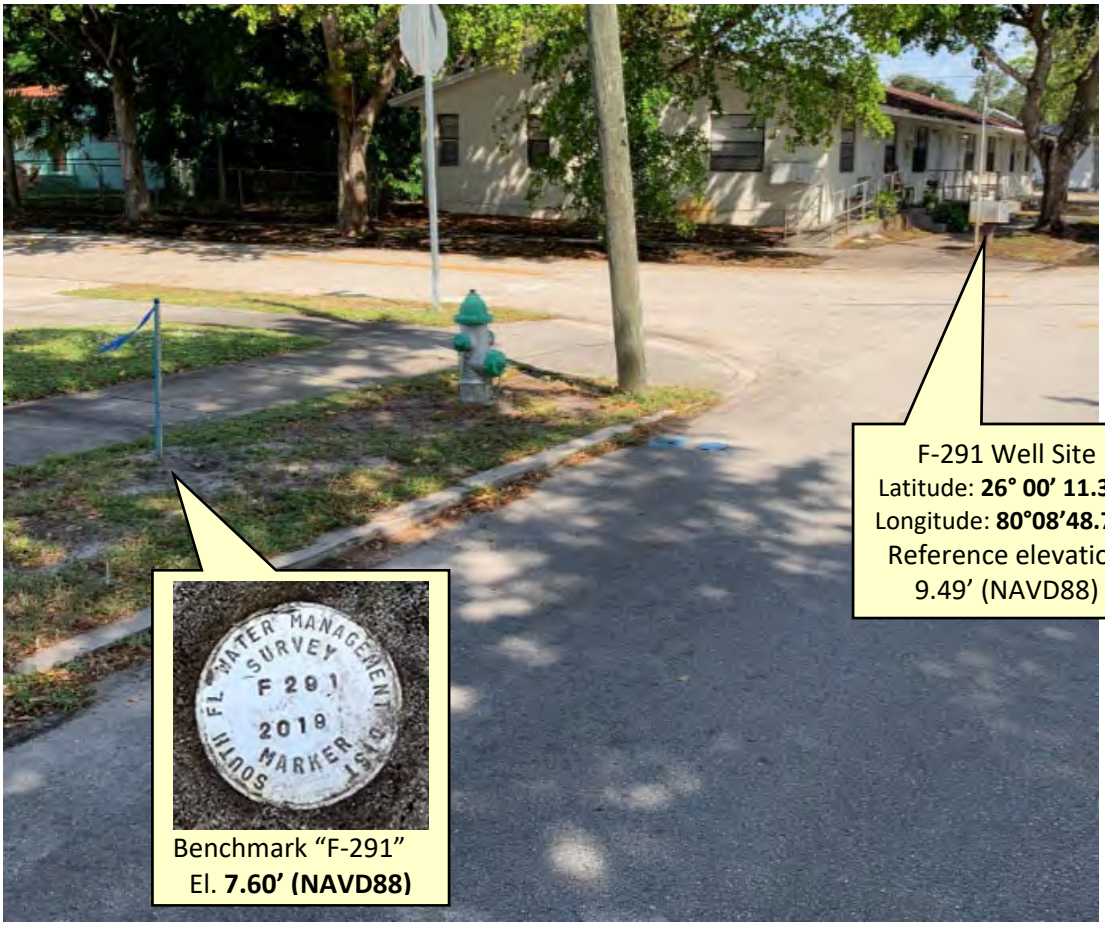


26 Nov 19 CM MK W210/58

SUNNY 72°

PROJECT RESULTS

Overall Site



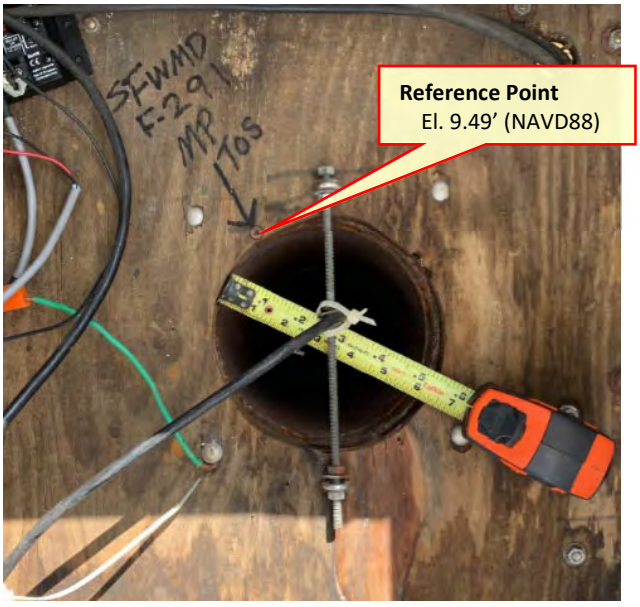
Looking Northwesterly (Oblique not to scale)

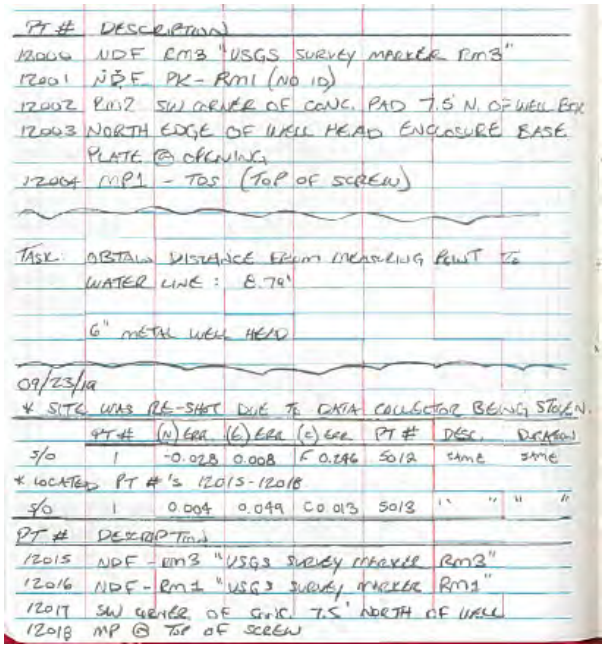
Tabular Form

Reference and Ground Elevations: NAVD88			
Well	Ground Elevation	Reference Elevation	Comments
F-291	7.60 ft.	9.49 ft.	Top of screw at well opening
Offset to NGVD29: +1.60' (See Project Vertical Datum Notes in Page: 4)			
Well diameter		Casing material	DTW
6" Metal Well Head		Metal	-8.79 ft. (9/19/19 at 10:30 AM)

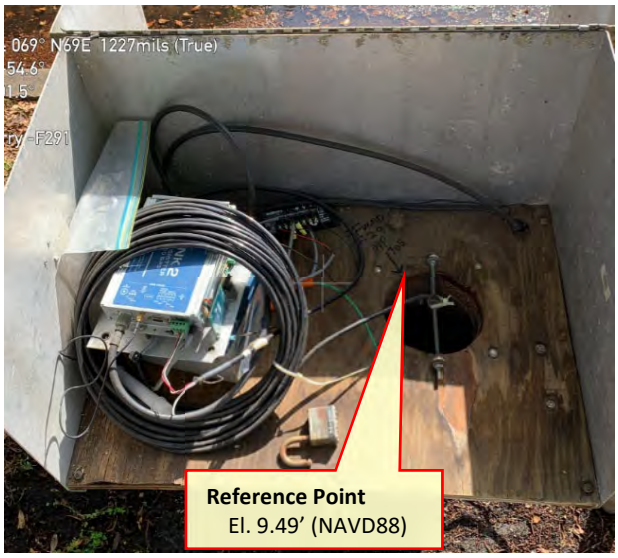
Source & Site Benchmark	NAVD88	NGVD29 (Published)	NGVD29 (Corpscon)
NGS "MORRIS AZ MK" (AC4697)	12.30 ft. (Published)	13.91 ft.	
BM F-291 (SFWMD)	7.60 ft. (Measured)		9.198 ft. (Converted)

Well Photos and Diagrams (Continued)





Well Photos and Diagrams (Continued)



Overhead View (Oblique Not to scale)

Surveyors' Notes:

1. All measurements herein are in United States Survey feet and decimal thereof, unless otherwise specified.
2. Underground utilities were not located as part of this survey.
3. This survey report or copies thereof are not valid without the original signature and seal of a Florida licensed Surveyor and Mapper.
4. Additions or deletions to this survey report by other than the signing party (or parties) is prohibited without written consent of the signing party (or parties).
5. To convert from NAVD 88 to NGVD 29 add 1.60 feet. This value is based on Corpscon 6.0.1 a U.S. Army Corps of Engineers Engineering Research and Development Center Topographic Engineering Center Alexandria, Virginia Windows-based program to convert coordinates and elevations between datum's using vertcon05.txt and vertcon05.05 files supplied by the U.S. Army Corps of Engineers South Atlantic Division, Jacksonville Fl.
6. Date of last field work: November 26, 2019, PO NO: 9500008146
7. SFWMD Data records (on file at the District's headquarters):
8. A. Electronic Data files:
   Miscellaneous picture files
   B. Conventional reporting
   Field Book: W210 page 58

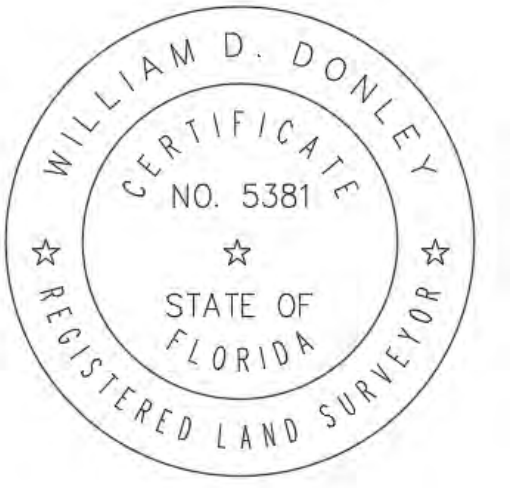
Abbreviations:

Elev.	-	Elevation
DTW	-	Distance to the water table inside the well
BroCo.	-	Broward County
NAVD88	-	North American Vertical Datum of 1988
NGVD29	-	National Geodetic Vertical Datum of 1929
NGS	-	National Geodetic Survey
PSM	-	Professional Surveyor & Mapper
PID	-	Permanent Identifiers
SFWMD	-	South Florida Water Management District
USGS	-	United States Geological Survey
MP	-	Monitoring Point
GS	-	Ground Shot
BM	-	Benchmark
RM	-	Reference Monument

SURVEYOR'S CERTIFICATION

In my professional opinion this Specific Purpose Survey meets applicable portions of the Standards of Practice set forth by the Florida Board of Professional Surveyors and Mappers in Chapter 5J-17, Florida Administrative Code. This report is prepared for the sole and specific use of the South Florida Water Management District and is not assignable.

Last date of Survey
Nov. 26, 2019



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South Florida Water Management District Benchmark Datasheet

Designation: F-291	Project Name: USGS Ph 2, BROWARD	Type: V	State Plane Zone: FL East
Stamping: F291 2019	Field Book Name: W210	Field Book Page: 53	
Established By: DEWBERRY / WHIDDEN	Recovered By: N/A	Recovery Date: N/A	
Surveyor: WILLIAM D. DONLEY	Established Date: 11/26/19	Status: New	

GEOGRAPHIC POSITION INFORMATION

Section: 22	Township: 51 SOUTH	Range: 42 EAST			
County: BROWARD	Quadrangle: FORT LAUDERDALE SOUTH	Quad Index: 1702	NGS Source BM(s):	MORRIS AZ MK	
NAD83 Adj. Year: 2011	Vertical Datum: NAVD1988	Horizontal Datum: NAD1983	NGS PID(s):	AC4697	
NAVD88 Elevation (feet): 7.6	NGVD29 Elevation (feet): 9.198	2022 Elevation: N/A	NGS NAVD88 Elev (ft):	12.3	
NAVD88 Class: N/A	NGVD29 Class: N/A	Other Elevation: N/A	NGS NAVD88 Elev (m):	3.75	
NAVD88 Order: 3	NGVD29 Order: N/A	Other Elevation Type: N/A	NGS 2022 Elev (ft):	N/A	

CORPSCON 6.0.1 CONVERSION FACTOR (NAVD88 TO NGVD29): (A U.S. Army Corps of Engineers Engineering Research and Development Center Topographic Engineering Center Alexandria, Virginia Windows-based program to convert coordinates and elevations between datums using vertcon05.txt and vertcon05.05 files supplied by the U.S. Army Corps of Engineers South Atlantic Division (Jacksonville FL))

Vertical Datum Offset: +	1.60	Actual NGS Elevation or ngvd29.txt file:	N/A	OPUS Ortho Height:	N/A
Northing (Y) (feet):	607690.7	Easting (X) (feet):	936374.8	Source of Latitude & Longitude:	AVERAGED FPRN & TRIMBLE VRSNOW RTK
Latitude:	26	0	10.75	Longitude:	80	8	48.75
	DD°	MM'	SS"		DD°	MM'	SS"
Latitude (Decimal Degrees):	26.002986			Longitude (Decimal Degrees):	-80.146875		

RECOVERY DATA

How to Reach:	1. FROM US-1, HEAD WEST ON WASHINGTON STREET FOR 0.25 MI 2. TURN LEFT ONTO S 20TH AVE, CONTINUE 378 FEET TO THE MARK ON THE RIGHT LOCATED APPROXIMATLEY 3.5 FEET EAST OF SIDEWALK EDGE AND 13 FEET SOUTH OF LIGHT POLE AT THE SW CORNER OF DEWEY STREET AND S 20TH AVE.
Description/Notes:	2" ALUMINUM SFWMD DISK SET IN A POURED IN PLACE CONCRETE MONUMENT

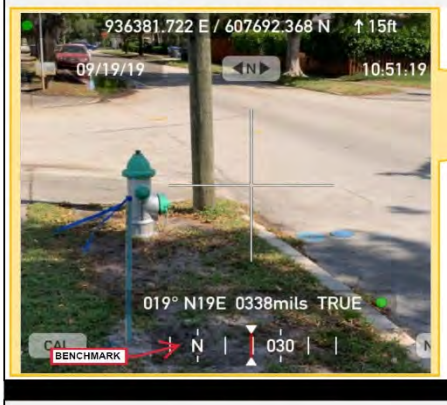
Notable Landmarks:

Other Source Benchmarks: N/A

PICTURES

Aerial View of Overall Site

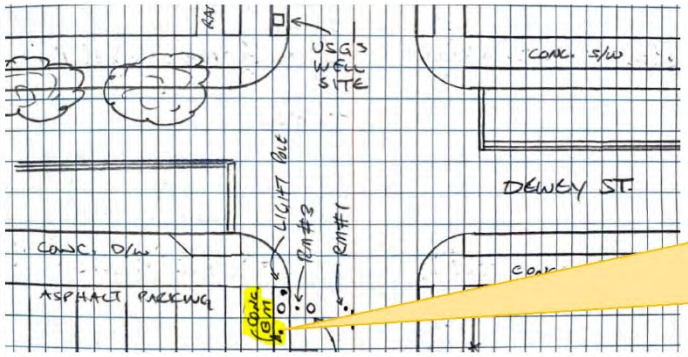
NOT TO SCALE. AERIAL FROM GOOGLEEARTH.



N

PICTURES

Site Sketch



Page 1 of 1

SOUTH FLORIDA WATER MANAGEMENT DISTRICT

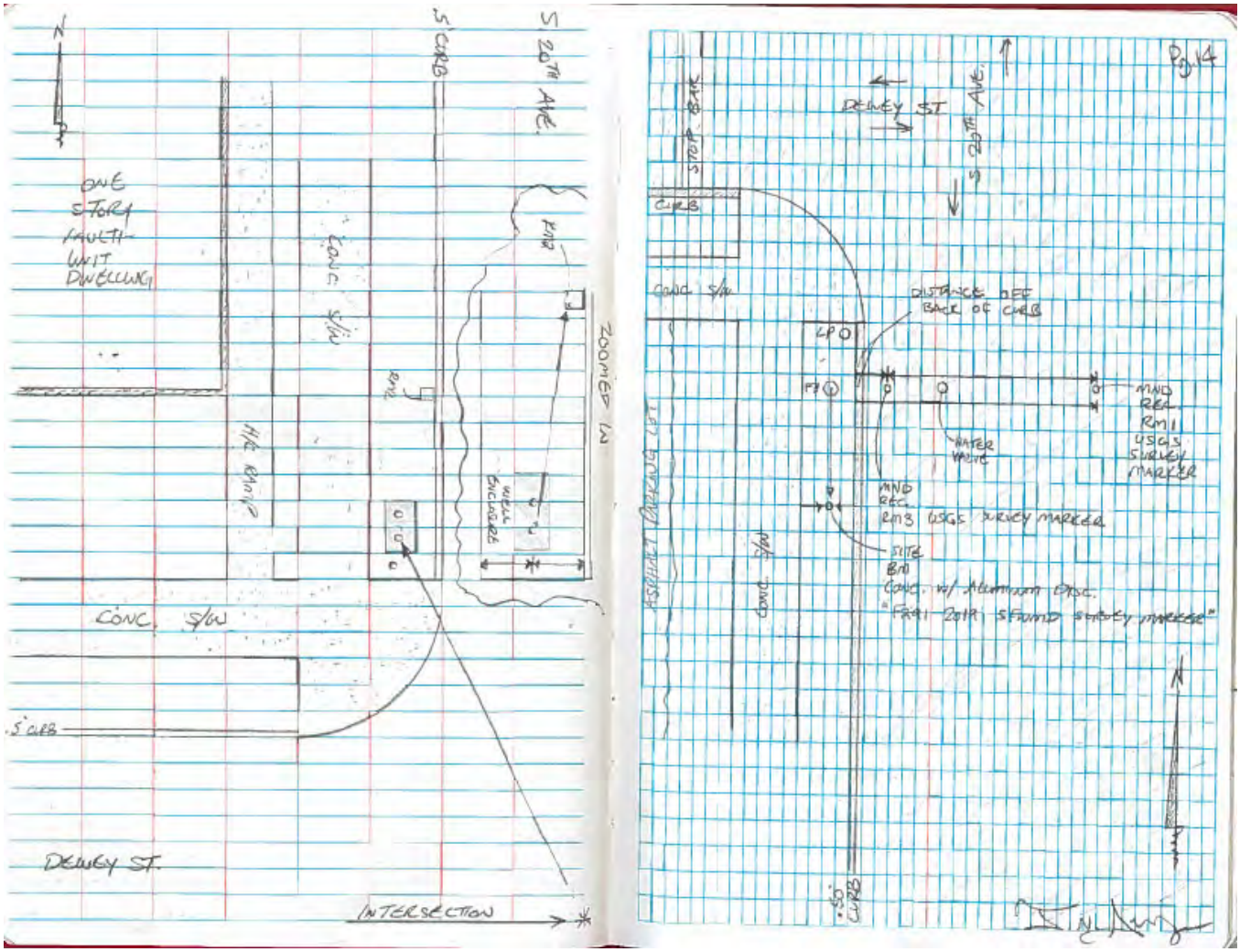
Benchmark "**F-291**"
Latitude**: 26°00'10.8"**
Longitude: **80°08'48.8"**
NAVD88 EL = 7.60 FEET

NOT TO SCALE (Google Earth Product)

SOUTH FLORIDA WATER MANAGEMNT DISTRICT

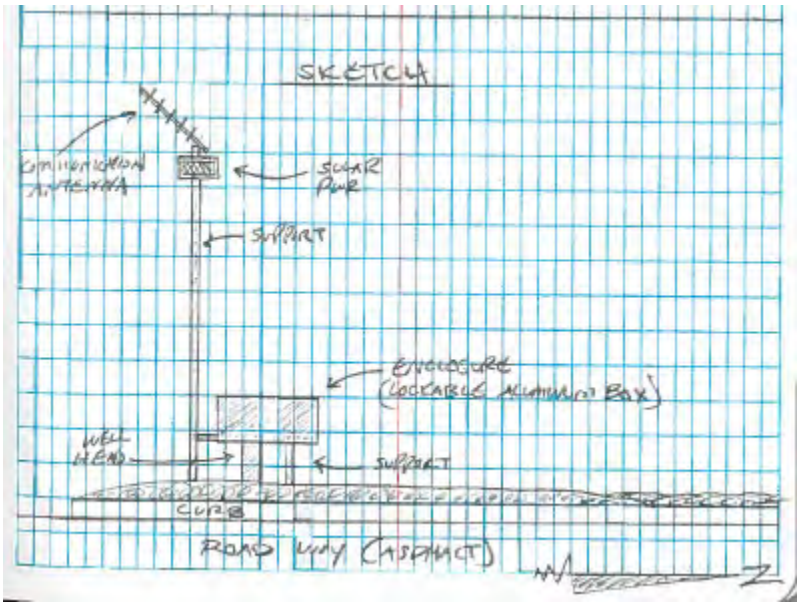
SKETCH

FIELD BOOK SFWMD #1, PAGE 14

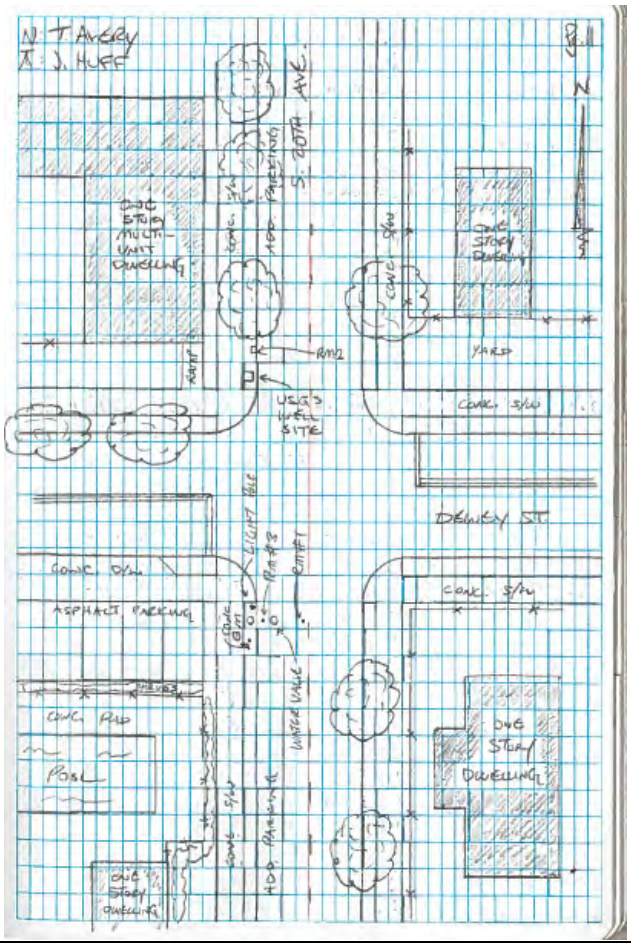


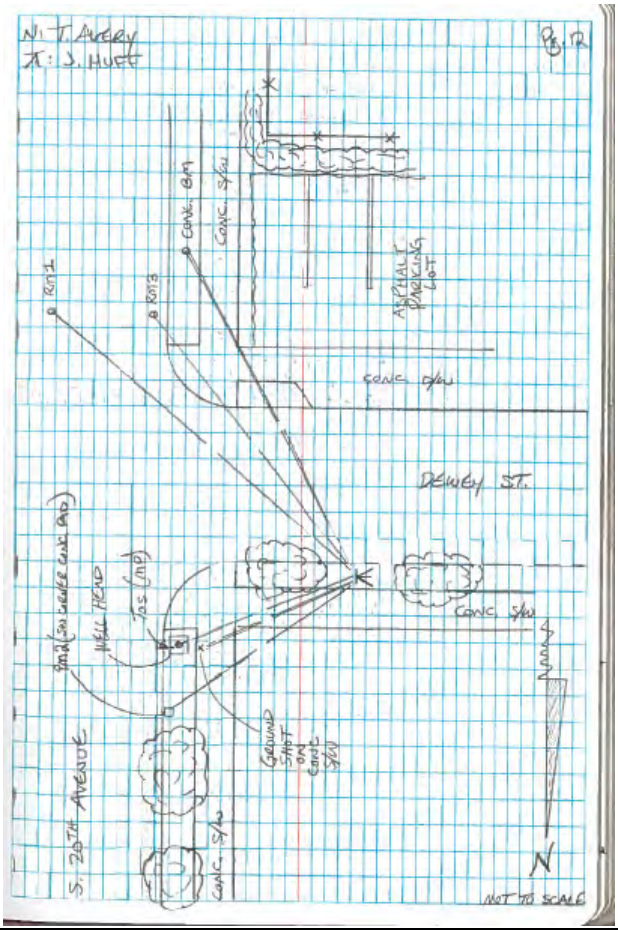
SOUTH FLORIDA WATER MANAGEMNT DISTRICT

FIELD BOOK SFWMD #1, PAGE 13



FIELD BOOK SFWMD #1, PAGES 11 & 12





Office

Project

2 December 2019

INPUT

State Plane, NAD83
0901 - Florida East, U.S. Feet
Vertical - NAVD88, U.S. Feet

OUTPUT

Geographic, NAD83
Vertical - NGVD29 (Vertcon94), U.S. Feet

BM F-291

1/2

Northing/Y: 607690.7
Easting/X: 936374.8
Elevation/Z: 7.6
Convergence: 0 22 26.57159
Scale Factor: 1.000031210
Combined Factor: 1.000034861

Latitude: 26 00 10.75196
Longitude: 80 08 48.75316
Elevation/Z: 9.198

WELL F-291

2/2

Northing/Y: 607754.34
Easting/X: 936373.11
Elevation/Z: 9.49
Convergence: 0 22 26.57390
Scale Factor: 1.000031209
Combined Factor: 1.000034769

Latitude: 26 00 11.38235
Longitude: 80 08 48.76713
Elevation/Z: 11.088

SPECTRA SE-80 SFWMD 09/19/19
ROVER S/N 0360 USGS WELLS + BMS E2°
TRIMBLE NETWORK JOB # 5009999 PARTLY CL.
HORIZONTAL LOCATIONS

STE F-291

	PT #	(N) ERR	(E) ERR	(Z) ERR	PT #	DESC	DURATION
S/O	1	-0.018	0.000	F 0.125	5002	CHK IN F291 BM	180 SEC
* LOCATE PTS		12000 - 12004					
S/O	1	0.081	-0.050	F 0.022	5003	CHK OUT F291 BM	" "

PT #	DESCRIPTION
12000	NDF BM3 "USGS SURVEY MARKER BM3"
12001	NDF PK - RM1 (NO ID)
12002	RM2 SW CORNER OF CONC. PAD 7.5' N. OF WELL BOX
12003	NORTH EDGE OF WELL HEAD ENCLOSURE BASE PLATE @ OPENING
12004	MP1 - TOS (TOP OF SCREW)

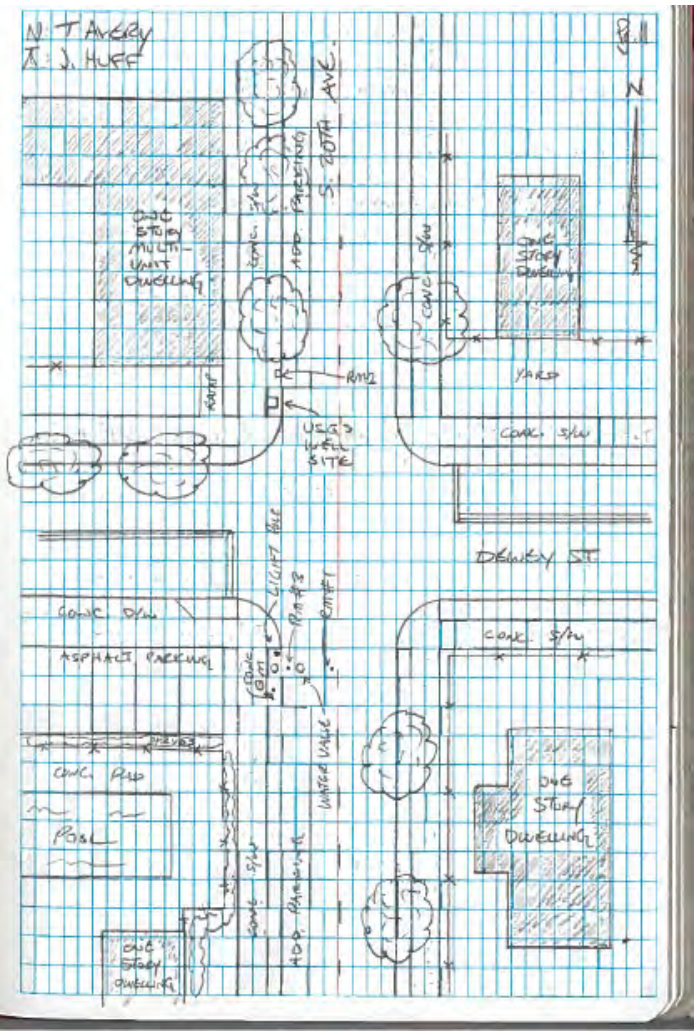
TASK: OBTAIN DISTANCE FROM UNKNOWN POINT TO WATER LINE : 8.74'

6" METAL WELL HEAD

09/23/19
* SITE WAS RE-SHOT DUE TO DATA COLLECTOR BEING STOLEN

	PT #	(N) ERR.	(E) ERR.	(Z) ERR.	PT #	DESC.	DURATION
S/O	1	-0.028	0.008	F 0.246	5012	same	same
* LOCATED	PT #'s 12015 - 12018						
S/O	1	0.004	0.049	C 0.013	5013	"	"

PT #	DESCRIPTION
12015	NDF - BM3 "USGS SURVEY MARKER BM3"
12016	NDF - RM1 "USGS SURVEY MARKER RM1"
12017	SW CORNER OF CONC. 7.5' NORTH OF WELL
12018	MP @ TOP OF SCREW



TOPCON | S.F.W.M.D | 06/19/19
AT-G2 | U.S.G.S WELLS & BMS | 82°
S/N: 1939 | JOB # 50099949 | PARTLY CL.
ELEVATE PTS

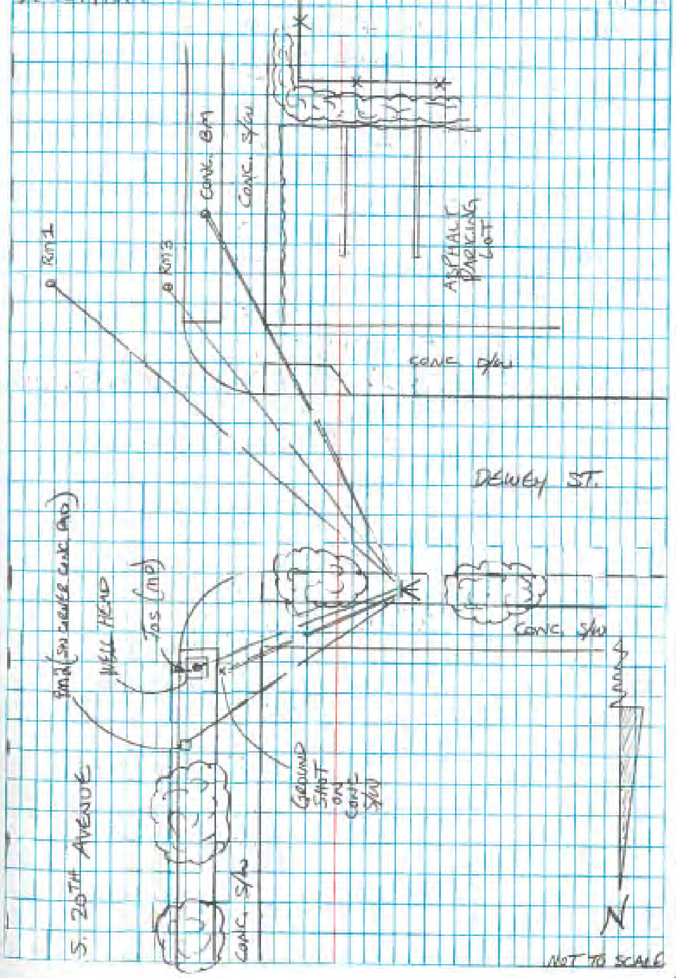
BM ELEVATION: ~~100.00~~ 7.60 (WHIDDEN)

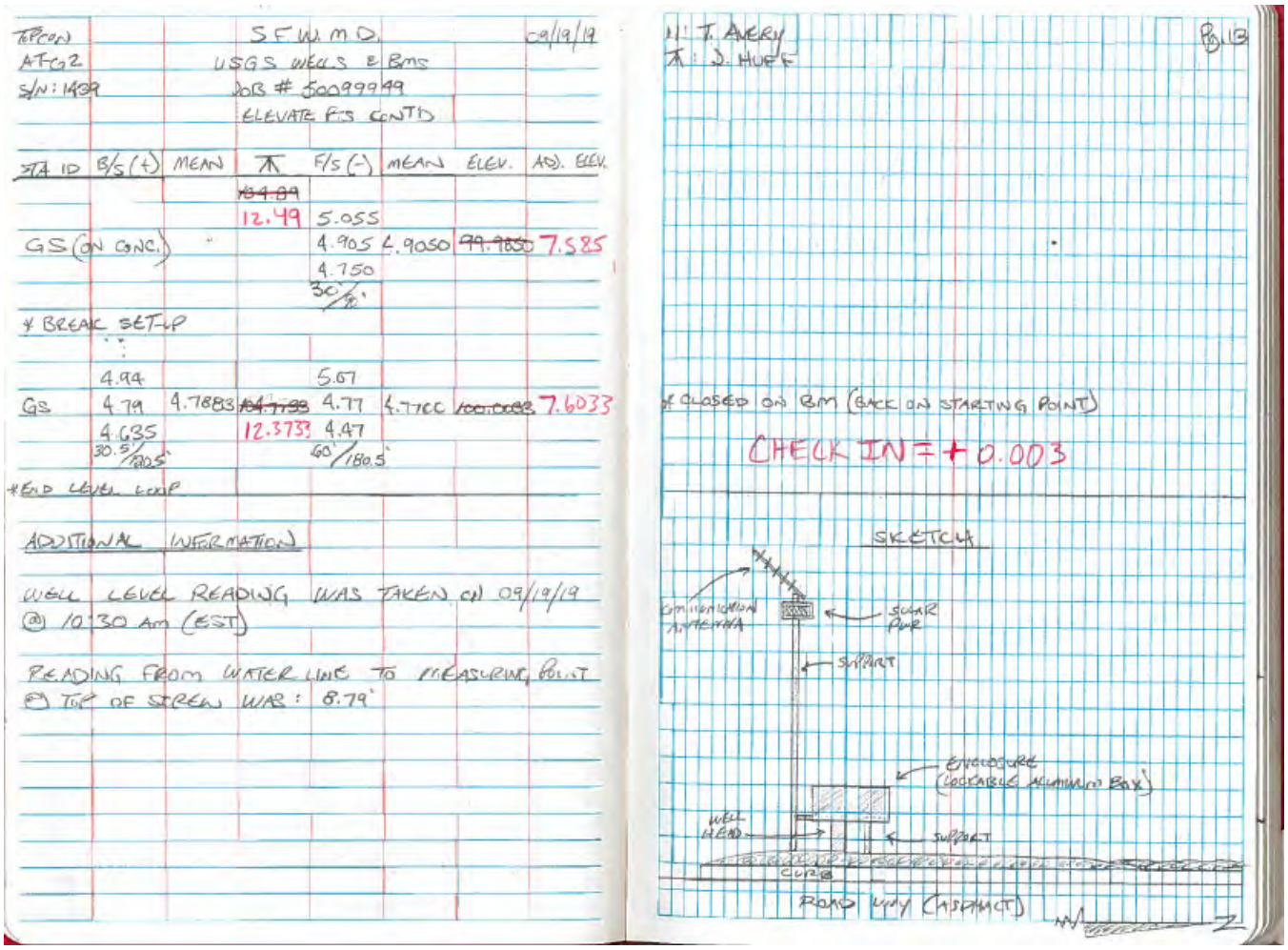
STA ID	B/S (+)	MEAN	⊼	F/S (-)	MEAN	ASMD ELEV.	ADJ. ELEV.
						~~100.00~~	7.60
	5.19						
F291BM	4.89	4.89	~~104.89~~				
	4.59		12.49				
	60'/60'						
				5.365			
RM3			12.49	5.08	5.0783	~~99.8117~~	7.4117
				4.79			
				57.5'/			
				5.31			
RM1			12.49	5.00	5.0000	~~99.8900~~	7.49
				4.69			
				62'/			
				4.885			
RM2			12.49	4.695	4.6950	~~100.1950~~	7.795
				4.505			
				38'/			
				3.165			
TOS (TOP OF SCREW)			12.49	3.005	3.0050	~~101.8850~~	9.485
				2.845			
				32'/			

* CONTINUED ON PG. 13

N: T. AVERY
⊼: J. HUFF

Pg. 12





TOPCON
AT-G2
S/N: 1939

SFWMD
USGS WELLS & BMS
JOB # 50099999
ELEVATE F:S CONTD

09/19/19

STA ID	B/S (+)	MEAN	▲	F/S (-)	MEAN	ELEV.	ADJ. ELEV.
			~~84.89~~				
			12.49	5.055			
GS (ON CONC.)				4.905	4.9050	~~99.9850~~	7.585
				4.750			
				30'/			
# BREAK SET-UP							
	4.94			5.07			
GS	4.79	4.7883	~~84.7788~~	4.77	4.7700	~~100.0088~~	7.6033
	4.635		12.3733	4.47			
	30.5'/180.5'			60'/180.5'			
#END LEVEL LOOP							

ADDITIONAL INFORMATION

WELL LEVEL READING WAS TAKEN ON 09/19/19 @ 10:30 AM (EST)

READING FROM WATER LINE TO MEASURING POINT OF TOP OF SCREEN WAS: 8.79'

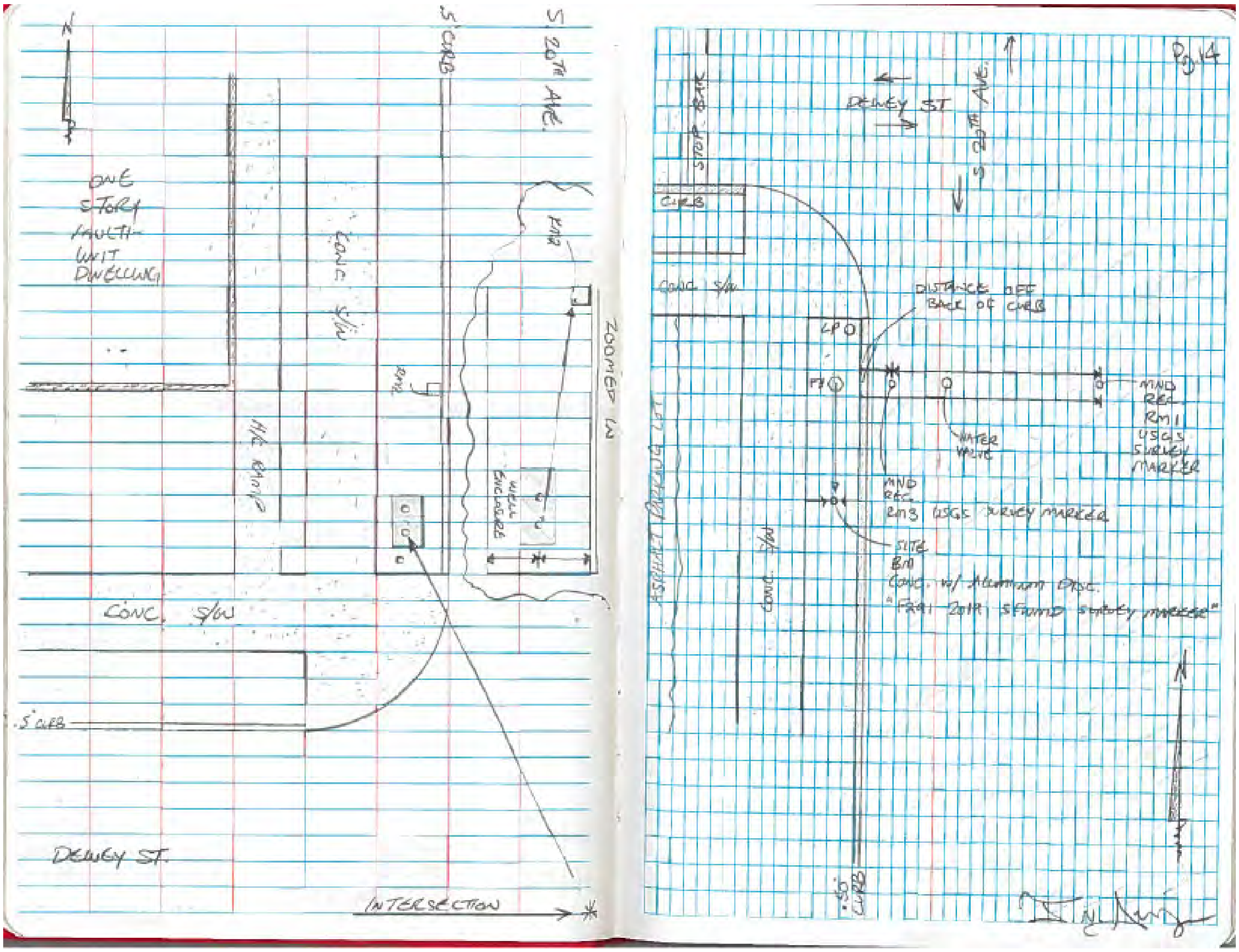
T: T. AVERY
A: J. HUFF

BM 13

CLOSED ON BM (BACK ON STARTING POINT)

CHECK IN = + 0.003

SKETCH


S. 20TH AVE.
.5' CURB
ONE STORY MULTI-UNIT DWELLING
CONC. S/W
A/C RAMP
WELL ENCLOSURE
ZOOMED IN
CONC. S/W
.5' CURB
DEWEY ST.
INTERSECTION
Pg. 4
DEWEY ST
S. 20TH AVE.
CURB
CONC. S/W
DISTANCE OFF BACK OF CURB
LPO
WATER VALVE
WIND REF. RM1 USGS SURVEY MARKER
WIND REF. RM3 USGS SURVEY MARKER
SITE BM
ASPHALT PARKING LOT
CONC. S/W
.50' CURB

The NGS Data Sheet

See file dsdata.pdf for more information about the datasheet.

```
PROGRAM = datasheet95, VERSION = 8.12.5.4
1        National Geodetic Survey,   Retrieval Date = NOVEMBER 19, 2019
 AC4697 ***********************************************************************
 AC4697  DESIGNATION -  MORRIS AZ MK
 AC4697  PID         -  AC4697
 AC4697  STATE/COUNTY-  FL/BROWARD
 AC4697  COUNTRY     -  US
 AC4697  USGS QUAD   -  NORTH MIAMI (1988)
 AC4697
 AC4697                         *CURRENT SURVEY CONTROL
 AC4697  ______________________________________________________________________
 AC4697* NAD 83(1986) POSITION- 25 59 39.7    (N) 080 09 40.0    (W)   HD_HELD2
 AC4697* NAVD 88 ORTHO HEIGHT -     3.750 (meters)       12.30  (feet) ADJUSTED
 AC4697  ______________________________________________________________________
 AC4697  GEOID HEIGHT    -        -25.558 (meters)                     GEOID18
 AC4697  DYNAMIC HEIGHT  -          3.744 (meters)       12.28  (feet) COMP
 AC4697  MODELED GRAVITY -    979,052.3   (mgal)                       NAVD 88
 AC4697
 AC4697  VERT ORDER      -  FIRST     CLASS II
 AC4697
 AC4697.The horizontal coordinates were established by autonomous hand held GPS
 AC4697.observations and have an estimated accuracy of +/- 10 meters.
 AC4697.
 AC4697.The orthometric height was determined by differential leveling and
 AC4697.adjusted by the NATIONAL GEODETIC SURVEY
 AC4697.in May 1994.
 AC4697
 AC4697.Significant digits in the geoid height do not necessarily reflect accuracy.
 AC4697.GEOID18 height accuracy estimate available here.
 AC4697
 AC4697.Click here to see if photographs exist for this station.
 AC4697
 AC4697.The dynamic height is computed by dividing the NAVD 88
 AC4697.geopotential number by the normal gravity value computed on the
 AC4697.Geodetic Reference System of 1980 (GRS 80) ellipsoid at 45
 AC4697.degrees latitude (g = 980.6199 gals.).
 AC4697
 AC4697.The modeled gravity was interpolated from observed gravity values.
 AC4697
 AC4697;                    North         East     Units  Estimated Accuracy
 AC4697;SPC FL E     -   184,260.      283,989.      MT  (+/- 10 meters HH2 GPS)
 AC4697
 AC4697_U.S. NATIONAL GRID SPATIAL ADDRESS: 17RNJ8395975328(NAD 83)
 AC4697
 AC4697                           SUPERSEDED SURVEY CONTROL
 AC4697
 AC4697  NGVD 29 (09/01/92)    4.239  (m)           13.91   (f) ADJUSTED    1 2
 AC4697
 AC4697.Superseded values are not recommended for survey control.
 AC4697
 AC4697.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
 AC4697.See file dsdata.pdf to determine how the superseded data were derived.
 AC4697
 AC4697_MARKER: DZ = AZIMUTH MARK DISK
 AC4697_SETTING: 7 = SET IN TOP OF CONCRETE MONUMENT
 AC4697_STAMPING: MORRIS 1971 1977
```

“MORRIS AZ MK” NGS Benchmark Datasheet (2 of 2)

```
AC4697_MARK LOGO: NGS
AC4697_PROJECTION: FLUSH
AC4697_STABILITY: C = MAY HOLD, BUT OF TYPE COMMONLY SUBJECT TO
AC4697+STABILITY: SURFACE MOTION
AC4697_SATELLITE: THE SITE LOCATION WAS REPORTED AS SUITABLE FOR
AC4697+SATELLITE: SATELLITE OBSERVATIONS - September 20, 2014
AC4697
AC4697  HISTORY     - Date     Condition        Report By
AC4697  HISTORY     - 1977     MONUMENTED       NGS
AC4697  HISTORY     - 19901218 GOOD             NGS
AC4697  HISTORY     - 20140920 GOOD             GEOCAC
AC4697
AC4697                          STATION DESCRIPTION
AC4697
AC4697'DESCRIBED BY NATIONAL GEODETIC SURVEY 1990
AC4697'1.8 KM (1.1 MI) WESTERLY ALONG PEMBROKE ROAD (STATE HIGHWAY 824) FROM
AC4697'THE INTERSECTION OF U.S. HIGHWAY 1 IN HALLANDALE, THENCE 0.2 KM (0.1
AC4697'MI) SOUTHERLY ALONG NORTHWEST 9TH AVENUE, 19.0 M (62.3 FT) WEST OF
AC4697'THE AVENUE CENTERLINE, 7.1 M (23.3 FT) SOUTHWEST OF AND LEVEL WITH
AC4697'THE CENTERLINE OF FOSTER ROAD, 6.4 M (21.0 FT) WEST OF UTILITY POLE
AC4697'NUMBER 87570087906, 1.0 M (3.3 FT) NORTH OF A WITNESS POST, 1.0 M
AC4697'(3.3 FT) SOUTH OF THE NORTH EDGE OF A SIDEWALK, AND THE MONUMENT IS
AC4697'FLUSH WITH AND SURROUNDED BY A SIDEWALK.  NOTE--THE ORIGINAL
AC4697'DESCRIPTION STATES THAT THE MONUMENT WAS SET IN A CONCRETE POST AND
AC4697'IT DOES APPEAR THAT THE SIDEWALK WAS POURED AROUND THE MONUMENT.
AC4697
AC4697                          STATION RECOVERY (2014)
AC4697
AC4697'RECOVERY NOTE BY GEOCACHING 2014 (KEN)
AC4697'RECOVERED IN GOOD CONDITION.

*** retrieval complete.
Elapsed Time = 00:00:01
```

Tom Whidden

From: opus <opus@ngs.noaa.gov>
Sent: Tuesday, November 26, 2019 11:26 PM
To: tom@whiddensurveying.com
Subject: OPUS solution : 24313301.19o OP1574828619288

FILE: 24313301.19o OP1574828619288

2005 NOTE: The IGS precise and IGS rapid orbits were not available
2005 at processing time. The IGS ultra-rapid orbit was/will be used to
2005 process the data.
2005

NGS OPUS SOLUTION REPORT
==========

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

USER: tom@whiddensurveying.com DATE: November 27, 2019
RINEX FILE: 2431330o.19o TIME: 04:25:05 UTC

SOFTWARE: page5 1801.18 master53.pl 160321 START: 2019/11/26 14:10:00
EPHEMERIS: igu20812.eph [ultra-rapid] STOP: 2019/11/26 18:12:00
NAV FILE: brdc3300.19n OBS USED: 6937 / 8544 : 81%
ANT NAME: TRMR8_GNSS NONE # FIXED AMB: 59 / 66 : 89%
ARP HEIGHT: 1.6919 OVERALL RMS: 0.025(m)

REF FRAME: NAD_83(2011)(EPOCH:2010.0000) ITRF2014 (EPOCH:2019.9032)

X:	981588.785(m)	0.002(m)	981587.967(m)	0.002(m)
Y:	-5651546.237(m)	0.012(m)	-5651544.640(m)	0.012(m)
Z:	2779349.146(m)	0.012(m)	2779348.978(m)	0.012(m)

LAT:	26 0 10.75266	0.007(m)	26 0 10.77214	0.007(m)
E LON:	279 51 11.24600	0.004(m)	279 51 11.22682	0.004(m)
W LON:	80 8 48.75400	0.004(m)	80 8 48.77318	0.004(m)
EL HGT:	-23.296(m)	0.016(m)	-24.910(m)	0.016(m)
ORTHO HGT:	2.318(m)	0.030(m)	[NAVD88 (Computed using GEOID18)]	

	UTM COORDINATES (UTM (Zone 17))	STATE PLANE COORDINATES (SPC (0901 FL E))
Northing (Y) [meters]	2876293.301	185224.517
Easting (X) [meters]	585378.446	285407.587
Convergence [degrees]	0.37404722	0.37404722
Point Scale	0.99969000	1.00003121
Combined Factor	0.99969366	1.00003487

OPUS REPORT (2 of 6)

US NATIONAL GRID DESIGNATOR: 17RNJ8537876293(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DP6859	FLF1 FL FOUNDATION 1 CORS ARP	N253655.240	W0802309.913	49190.0
DF9225	ZMA1 MIAMI WAAS 1 CORS ARP	N254928.585	W0801909.066	26240.7
DF7050	MTNT MIAMI TNT CORS ARP	N255156.760	W0805425.186	77645.6

NEAREST NGS PUBLISHED CONTROL POINT

AD7986	BC 528	N260018.000	W0800857.000	319.9

BASE STATION INFORMATION

STATION NAME: flf1 a 2 (FL Foundation 1; Miami, Florida United States)
MONUMENT: 40499M007

XYZ	961107.2800	-5674030.5187	2740689.2216	MON @ 2010.0000 (M)
XYZ	-0.0104	-0.0005	0.0023	VEL (M/YR)
NEU	-0.0000	0.0000	0.0083	MON TO ARP (M)
NEU	0.0006	0.0014	0.0897	ARP TO L1 PHASE CENTER (M)
NEU	0.0004	-0.0003	0.1162	ARP TO L2 PHASE CENTER (M)
XYZ	-0.1035	-0.0047	0.0230	VEL TIMES 9.9021 YRS
XYZ	0.0012	-0.0074	0.0036	MON TO ARP
XYZ	0.0149	-0.0792	0.0393	ARP TO L1 PHASE CENTER
XYZ	961107.1926	-5674030.6100	2740689.2875	L1 PHS CEN @ 2019.9032
XYZ	-0.0000	0.0000	-0.0000	+ XYZ ADJUSTMENTS
XYZ	961107.1926	-5674030.6100	2740689.2875	NEW L1 PHS CEN @ 2019.9032
XYZ	961107.1777	-5674030.5308	2740689.2481	NEW ARP @ 2019.9032
XYZ	961107.1765	-5674030.5234	2740689.2445	NEW MON @ 2019.9032
LLH	25 36 55.25977	279 36 50.06786	-21.9767	NEW L1 PHS CEN @ 2019.9032
LLH	25 36 55.25975	279 36 50.06781	-22.0664	NEW ARP @ 2019.9032
LLH	25 36 55.25975	279 36 50.06781	-22.0747	NEW MON @ 2019.9032

STATION NAME: zma1 a 2 (MIAMI WAAS 1; Miami, Florida, U.S.A.)
MONUMENT: NO DOMES NUMBER

XYZ	966042.2781	-5662999.4302	2761581.3071	MON @ 2010.0000 (M)
XYZ	-0.0111	0.0005	0.0022	VEL (M/YR)
NEU	0.0000	0.0000	0.0000	MON TO ARP (M)
NEU	0.0009	-0.0040	0.4444	ARP TO L1 PHASE CENTER (M)
NEU	-0.0011	-0.0011	0.4571	ARP TO L2 PHASE CENTER (M)
XYZ	-0.1097	0.0048	0.0222	VEL TIMES 9.9021 YRS
XYZ	0.0000	0.0000	0.0000	MON TO ARP
XYZ	0.0632	-0.3947	0.1944	ARP TO L1 PHASE CENTER
XYZ	966042.2316	-5662999.8200	2761581.5237	L1 PHS CEN @ 2019.9032
XYZ	-0.0000	0.0000	0.0000	+ XYZ ADJUSTMENTS
XYZ	966042.2316	-5662999.8200	2761581.5237	NEW L1 PHS CEN @ 2019.9032
XYZ	966042.1683	-5662999.4253	2761581.3293	NEW ARP @ 2019.9032
XYZ	966042.1683	-5662999.4253	2761581.3293	NEW MON @ 2019.9032
LLH	25 49 28.60483	279 40 50.91432	-7.5899	NEW L1 PHS CEN @ 2019.9032

LLH 25 49 28.60480 279 40 50.91447 -8.0344 NEW ARP @ 2019.9032
LLH 25 49 28.60480 279 40 50.91447 -8.0344 NEW MON @ 2019.9032

STATION NAME: mtnt a 3 (MIAMI TNT; Miami, Florida, U.S.A.)
MONUMENT: 49522S001
XYZ 907578.4336 -5670638.1065 2765679.6498 MON @ 2010.0000 (M)
XYZ -0.0112 -0.0003 0.0039 VEL (M/YR)
NEU 0.0000 0.0000 0.0000 MON TO ARP (M)
NEU 0.0001 -0.0008 0.1242 ARP TO L1 PHASE CENTER (M)
NEU -0.0000 -0.0008 0.1337 ARP TO L2 PHASE CENTER (M)
XYZ -0.1113 -0.0029 0.0384 VEL TIMES 9.9021 YRS
XYZ 0.0000 0.0000 0.0000 MON TO ARP
XYZ 0.0169 -0.1104 0.0543 ARP TO L1 PHASE CENTER
XYZ 907578.3392 -5670638.2198 2765679.7425 L1 PHS CEN @ 2019.9032
XYZ 0.0000 -0.0000 -0.0000 + XYZ ADJUSTMENTS
XYZ 907578.3392 -5670638.2198 2765679.7425 NEW L1 PHS CEN @ 2019.9032
XYZ 907578.3223 -5670638.1093 2765679.6882 NEW ARP @ 2019.9032
XYZ 907578.3223 -5670638.1093 2765679.6882 NEW MON @ 2019.9032
LLH 25 51 56.78045 279 5 34.79347 -20.4150 NEW L1 PHS CEN @ 2019.9032
LLH 25 51 56.78044 279 5 34.79350 -20.5392 NEW ARP @ 2019.9032
LLH 25 51 56.78044 279 5 34.79350 -20.5392 NEW MON @ 2019.9032

REMOTE STATION INFORMATION

STATION NAME: 2431 1
MONUMENT: NO DOMES NUMBER
XYZ 981588.0065 -5651544.7870 2779348.9701 MON @ 2019.9030 (M)
NEU -0.0006 0.0002 1.6919 MON TO ARP (M)
NEU 0.0006 -0.0002 0.0837 ARP TO L1 PHASE CENTER (M)
NEU -0.0007 -0.0002 0.0721 ARP TO L2 PHASE CENTER (M)
XYZ 0.2604 -1.4984 0.7413 MON TO ARP
XYZ 0.0127 -0.0739 0.0372 ARP TO L1 PHASE CENTER
XYZ 981588.2796 -5651546.3593 2779349.7486 L1 PHS CEN @ 2019.9032

BASELINE NAME: flf1 2431
XYZ -0.0387 0.1497 0.0096 + XYZ ADJUSTMENTS
XYZ 981588.2409 -5651546.2096 2779349.7581 NEW L1 PHS CEN @ 2019.9032
XYZ 981588.2283 -5651546.1358 2779349.7209 NEW ARP @ 2019.9032
XYZ 981587.9678 -5651544.6373 2779348.9797 NEW MON @ 2019.9032
LLH 26 0 10.77223 279 51 11.22688 -23.1357 NEW L1 PHS CEN @ 2019.9032
LLH 26 0 10.77221 279 51 11.22688 -23.2193 NEW ARP @ 2019.9032
LLH 26 0 10.77223 279 51 11.22688 -24.9113 NEW MON @ 2019.9032

BASELINE NAME: zma1 2431
XYZ -0.0394 0.1523 0.0007 + XYZ ADJUSTMENTS
XYZ 981588.2401 -5651546.2071 2779349.7492 NEW L1 PHS CEN @ 2019.9032
XYZ 981588.2275 -5651546.1332 2779349.7120 NEW ARP @ 2019.9032
XYZ 981587.9671 -5651544.6347 2779348.9708 NEW MON @ 2019.9032
LLH 26 0 10.77201 279 51 11.22687 -23.1420 NEW L1 PHS CEN @ 2019.9032
LLH 26 0 10.77199 279 51 11.22687 -23.2256 NEW ARP @ 2019.9032
LLH 26 0 10.77201 279 51 11.22687 -24.9176 NEW MON @ 2019.9032

```
BASELINE NAME:  mtnt 2431
XYZ      -0.0410       0.1401       0.0128  + XYZ ADJUSTMENTS
XYZ   981588.2386 -5651546.2193   2779349.7613  NEW L1 PHS CEN @ 2019.9032
XYZ   981588.2259 -5651546.1454   2779349.7241  NEW ARP @ 2019.9032
XYZ   981587.9655 -5651544.6469   2779348.9829  NEW MON @ 2019.9032
LLH  26  0 10.77219  279 51 11.22674   -23.1261  NEW L1 PHS CEN @ 2019.9032
LLH  26  0 10.77218  279 51 11.22674   -23.2098  NEW ARP @ 2019.9032
LLH  26  0 10.77219  279 51 11.22674   -24.9017  NEW MON @ 2019.9032

                    G-FILES

Axx20191126  191126
B201911261410  1911261811 1 page5 v1801.18IGS    132 1 2 27NGS   20191126IFDDPX
IITRF2014_2076       IGS   20191020
C00090002 -204807914   13 -224858861   58 -386597351   28 X3309A2431X3309AFLF1
D  1  2 -4073995  1  3  4233545  2  3 -8857691

Axx20191126  191126
B201911261410  1911261811 1 page5 v1801.18IGS    132 1 2 27NGS   20191126IFDDPX
IITRF2014_2076       IGS   20191020
C00090003 -155457987   12 -114547906   54 -177676415   25 X3309A2431X3309AZMA1
D  1  2 -3447941  1  3  3855702  2  3 -9009498

Axx20191126  191126
B201911261410  1911261811 1 page5 v1801.18IGS    132 1 2 27NGS   20191126IFDDPX
IITRF2014_2076       IGS   20191020
C00090001 -740096432   14 -190934624   60 -136692946   29 X3309A2431X3309AMTNT
D  1  2 -3056251  1  3  3235554  2  3 -9552571

          POST-FIT RMS BY SATELLITE VS. BASELINE

      OVERALL   02   05   10   12   13   14   15   20
flf1-2431|  0.028   ... 0.035 0.039   ... 0.028 0.025 0.027 0.020
        21   24   25   27   29   31   32
flf1-2431|   ... 0.026 0.017   ... 0.031 0.022 0.025

      OVERALL   02   05   10   12   13   14   15   20
zma1-2431|  0.025   ... 0.028 0.031 0.019 0.027 0.028 0.022 0.022
        21   24   25   27   29   31   32
zma1-2431|   ... 0.026 0.029   ... 0.027 0.021 0.023

      OVERALL   02   05   10   12   13   14   15   20
mtnt-2431|  0.023   ... 0.029 0.029 0.039 0.020 0.024 0.020 0.019
        21   24   25   27   29   31   32
mtnt-2431|   ... 0.023 0.030   ... 0.026 0.020 0.018

             OBS BY SATELLITE VS. BASELINE

      OVERALL   02   05   10   12   13   14   15   20
flf1-2431|  2385   ...   85  235   ...  190  138  350  436
        21   24   25   27   29   31   32
flf1-2431|   ...  392    4   ...  227   25  303
```

```
       OVERALL   02   05   10   12   13   14   15   20
zma1-2431|  2233   ...   54  218   18  192   96  331  436
         21   24   25   27   29   31   32
zma1-2431|   ...  380    4   ...  209   24  271
       OVERALL   02   05   10   12   13   14   15   20
mtnt-2431|  2319   ...   42  202   26  163  141  362  433
         21   24   25   27   29   31   32
mtnt-2431|   ...  402    4   ...  216   25  303
```

ITRF position of 2431 as determined by individual baselines

	X	Y	Z
flf1	981587.968	-5651544.637	2779348.980
zma1	981587.967	-5651544.635	2779348.971
mtnt	981587.966	-5651544.647	2779348.983

Residuals of position determined by individual baselines from the final position

	X	Y	Z	East	North	Up
flf1	0.001	0.002	0.002	0.001	0.003	-0.001
zma1	0.000	0.005	-0.007	0.001	-0.004	-0.007
mtnt	-0.001	-0.007	0.005	-0.003	0.002	0.008

Covariance Matrix for the xyz OPUS Position (meters^2).

0.0000011311	-0.0000001750	0.0000000891
-0.0000001750	0.0000219556	-0.0000009593
0.0000000891	-0.0000009593	0.0000050000

Covariance Matrix for the enu OPUS Position (meters^2).

0.0000016819	0.0000013904	-0.0000030447
0.0000013904	0.0000073653	-0.0000058421
-0.0000030447	-0.0000058421	0.0000190394

Horizontal network accuracy = 0.00557 meters.
Vertical network accuracy = 0.00856 meters.

Derivation of NAD 83 vector components

Position of reference station ARP in NAD_83(2011)(EPOCH:2010.0000).

	Xa(m)	Ya(m)	Za(m)	
FLF1	961107.99174	-5674032.13227	2740689.41913	2010.00
ZMA1	966042.98929	-5663001.03439	2761581.50007	2010.00
MTNT	907579.14428	-5670639.70699	2765679.84368	2010.00

Position of reference station monument in NAD_83(2011)(EPOCH:2010.0000).

	Xr(m)	Yr(m)	Zr(m)	
FLF1	961107.99054	-5674032.12487	2740689.41553	2010.00
ZMA1	966042.98929	-5663001.03439	2761581.50007	2010.00
MTNT	907579.14428	-5670639.70699	2765679.84368	2010.00

Velocity of reference station monument in NAD_83(2011)(EPOCH:2010.0000).

	Vx (m/yr)	Vy (m/yr)	Vz (m/yr)
FLF1	-0.01040	-0.00050	0.00230
ZMA1	-0.01110	0.00050	0.00220
MTNT	-0.01120	-0.00030	0.00390

Vectors from unknown station monument to reference station monument
in NAD_83(2011)(EPOCH:2010.0000).

	Xr-X= DX(m)	Yr-Y= DY(m)	Zr-Z= DZ(m)	
FLF1	-20480.79446	-22485.88787	-38659.73047	2010.00
ZMA1	-15545.79571	-11454.79739	-17767.64593	2010.00
MTNT	-74009.64072	-19093.46999	-13669.30232	2010.00

STATE PLANE COORDINATES - U.S. Survey Foot
SPC (0901 FL E)

Northing (Y) [feet]	607690.770
Easting (X) [feet]	936374.725
Convergence [degrees]	0.37404722
Point Scale	1.00003121
Combined Factor	1.00003487

********** New Reference Frame Preview **********

We are replacing the nation's NAD 83 and NAVD 88 datums, to improve access and accuracy of the National Spatial Reference System. More at https://geodesy.noaa.gov/datums/newdatums/

Below are approximate coordinates for this solution in the new frames:

APPROX ORTHO HGT: 2.380 (m) [PROTOTYPE (Computed using xGeoid19B,GRS80,ITRF2014)]

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.