Investigation of the Trench Collapse at I-95 on February 4, 2018, in Miami, FL

U.S. Department of Labor
Occupational Safety and Health Administration
Directorate of Construction

June 2018

Report Prepared by
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Office of Engineering Services
Directorate of Construction

The Project

The project was the I-95 Miami rehabilitation project in Miami, Florida. Archer Western Contractors, Ltd. (Archer Western) was the contractor of the project. The project included the removal and replacement of concrete pavement within the established project limits, such as replacement of all asphalt shoulder pavement with full depth concrete shoulder pavement. The project also included drainage modifications and new concrete barrier walls in the center median of the I-95, see Figures 1 and 2.

After Archer Western installed the buried drainage pipe involved in the incident, video evidence from the pipeline video inspection indicated that the pipe was either damaged during construction or mis-installed. Therefore, Archer Western decided to open a trench to repair/replace the pipe, see Figure 3, and had its employees to hand-dig the trench along the concrete barrier wall. The trench was approximately three and one-half feet deep, approximately 2 feet 10 inches wide and more than one hundred and thirty feet long. The concrete barrier wall involved in the incident was approximately 121 feet long, see Figure 4.

The Incident

On February 4, 2018, around 3:00 a.m., two employees of Archer Western were inside the trench working on the pipe. The entire concrete barrier wall, approximately 121 feet long, collapsed into the trench killing the two employees who were in the trench.

Analysis and Discussion

The trench cross section, shown in Figure 3, is based on the observations and measurements obtained from our field visit on February 6, 2018. The concrete barrier wall sat directly on the utility trench, which was backfilled with flowable fill. Other than the subgrade soil underneath, the concrete barrier wall was not supported by or secured to any other structures, such as an inlet or pavement shoulder, see Figures 4 to 6.

The loads imposed on the subgrade soil from the concrete barrier wall was not limited to the immediate area of the wall, but also extended some distance away from the wall. This distance can be estimated as being equal to the depth of the excavation. Thus, a critical plane is formed sloping up from the bottom of the excavation toward the wall at an angle of 45 degrees, see Figure 3. Since the footing of the concrete barrier wall remained completely above the critical plane, according to the discussions in the preamble to OSHA's excavation standards (at 54 Federal Register 45924, October 31, 1989), the stability of the concrete barrier wall was endangered by the excavation operations. Therefore, per OSHA standard CFR 1926.651(i)(1) support systems should have been provided to ensure stability of the concrete barrier wall to protect employees working the trench.

During our site visit, the excavated soil was classified as OSHA Type C soil according to the site conditions and natural characteristics of the earth deposits, see Figures 5 and 6. Based on the OSHA laboratory test (see Appendix A), the sample of earth deposits collected at the incident site was further classified as granular sand with no cohesion, corresponding to OSHA Type C soil.

The soil sample contained 91.7% sand and gravel. At the incident site, it was also observed that large clumps of excavated spoil broke into small pieces without difficulty. Besides, approximately 0.1 inches of rain fell within 24 hours of the incident (see Appendix B for national climatic data). These facts confirmed that the subgrade soil at the incident site was not able to sustain the concrete barrier wall when the collapse occurred.

Conclusions

Based upon the above, we conclude that:

1) The cause of the failure was the instability of the concrete barrier wall. The instability of the concrete barrier wall was caused by the trench excavation operations.
2) No support systems such as shoring, bracing, or underpinning were provided by Archer Western to ensure the safety of employees and the stability of the concrete barrier wall, prior to, during and after the trench was opened.
3) Archer Western violated the OSHA standard CFR 1926.651(i)(1) by not providing a support system, such as shoring, bracing, or underpinning to ensure stability of the concrete barrier wall for the protection of the employees.
4) Archer Western violated the OSHA standard CFR 1926.651(k)(1) by not conducting any inspection of the excavation and the adjacent areas by a competent person prior to the start of the work or as needed throughout the shift, on or prior to 02/04/2018.

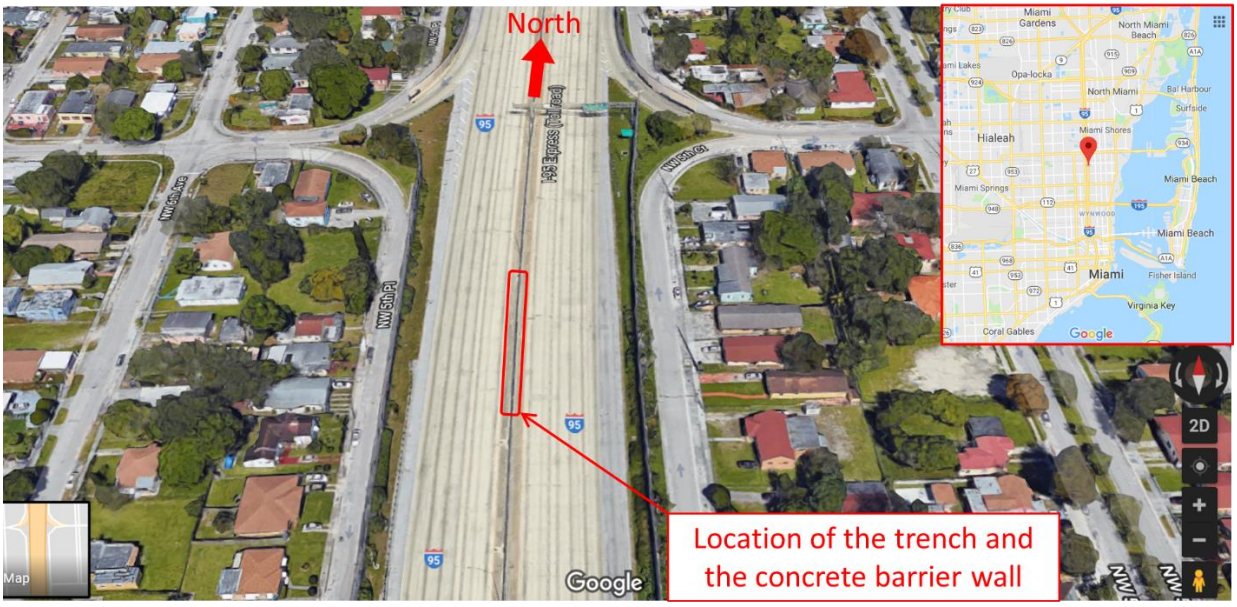

Figure 1 Project site (courtesy of Google.com)

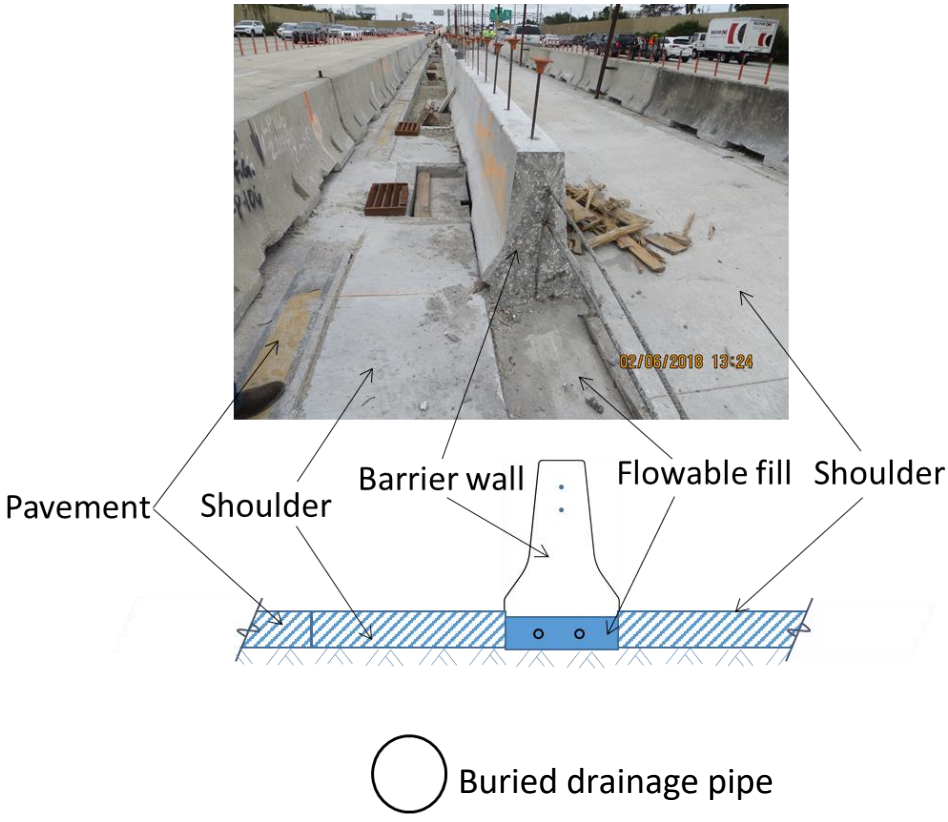

Figure 2 Typical section before excavation – looking north

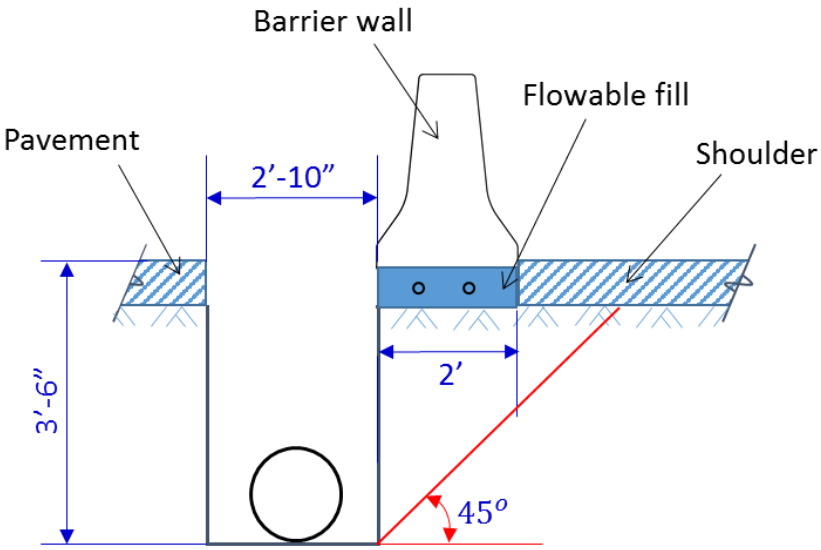

Figure 3 Typical section of the excavation prior to the collapse – looking north

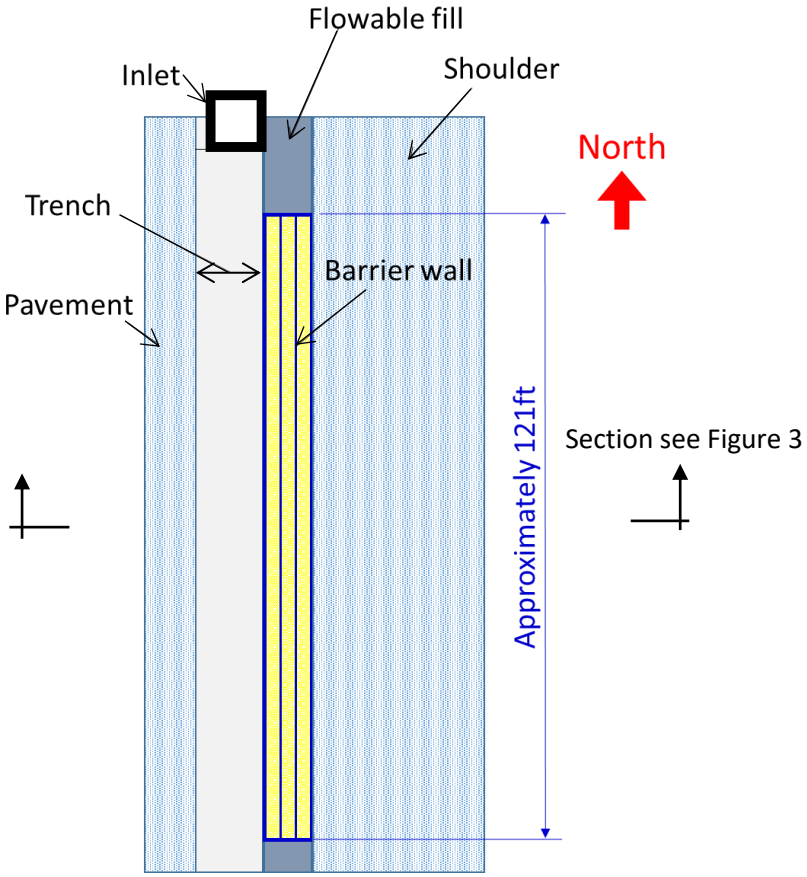

Figure 4 Plan view of the incident site

Figure 5 Scene of incident – looking south (North end of the barrier wall)

Figure 6 South end of the concrete barrier wall

Air Sampling Report U.S. Department of Labor Occupational Safety and Health Administration.

1. Reporting ID	2. Inspection Number	3. Sampling Number
418800	1293032	301406

4. Establishment Name: Archer Western Construction, LLC

5. CSHO ID	6. Sampling Date	7. Shipping Date	8.Date Result Received
J9763	06 FEB 2018	07 FEB 2018	

9. Job Title	10.Occupational Code	11. Number Exposed
Not applicable		

12. Frequency of Exposure

Exposure Summary

14. Substance Code	15. Rqstd	16. Smpl Type	17.Exp Type	18.Exp Level	19. Units	20. PEL	21. Adj	22. Severity	23. Citation information: No Cit	FTA	Over Exp	Eng	PPE	Trng	Med	OTH

TWA calculated on actual time sampled
The I. H. is free to make changes on the Form 91B and submit them directly to IMIS

26.Analyst's Comments (Analytical Method) OSHA ID-194

S15809 S777 Classification of S15809:

Textural: Sand
Structural: Granular
Type: C

This sample was classified as Type C because it contained 91.7% sand & gravel.

27.Chain of Custody a. Seals Intact	Init.	Date Y
b. Rec'd In Lab	KAS	20 MAR 2018
c. Rec'd by Anal.	DJH	26 MAR 2018
d. Anal. Completed	DJH	28 MAR 2018
e. Calc. Checked	SEA	28 MAR 2018
f. Supr. OK'd	DJH	28 MAR 2018

28 Submission number: HS-32

29 Lab Sample No. (Minutes/Type): S15809 B

30. Analyte	31. Analysis Results/	32. Sample included in calculations of
S777 Soil		N

Because the results for air samples are used in further calculations, the number of figures reported in section 31 may not reflect the actual precision of the analysis.
Calculated confidence limits (UCL & LCL) should be rounded to no more than three significant figures.
The precision of analysis for wipe samples and for bulk material samples justify rounding results to no more than two significant figures.

The Sampling and Analytical Error (SAE) is the current value for the specific chemical(s) and should be used for the calculations.
Blank values are reported for reference only. Appropriate blank corrections have been applied to the samples by the Salt Lake Technical Center. Blank results are less than the reporting limit(s) unless otherwise noted.

33. Analyte Code	SAE Value
S777	

L	MILLIGRAMS PER LITER (URINE)	D	MICROGRAMS PER DECILITER (BLOOD)
C	PICO CURIES PER LITER (RADON GAS)	P	PARTS PER MILLION
F	FIBERS PER CUBIC CENTIMETER	X	MICROGRAMS
M	MILLIGRAMS PER CUBIC METER	%	PERCENT
Y	MILLIGRAMS	E	FIBERS PER MM2
N	NONE	G	MILLION PARTICLES PER CUBIC FOOT (MPPCF)

Sampling Number: 301406

BM/S Bar Meters per Second mcg/ı Micrograms per Cubic Meter

Bulk samples are analyzed to provide an estimate of the composition of the material submitted. The results reported should be considered semi-quantitative only. Reporting limit for quartz in bulk samples is 1%

Analyte codes are chosen by the laboratory. The I. H. should review them for applicability. if there are any questions call the laboratory for appropriate analyte codes (ie. ICP uses fume analyte codes when the IH may have sampled for dust).

We value your comments regarding the customer support provided by the Salt Lake Technical Center Industrial Hygiene Chemistry Laboratory. You may leave comments (either positive or negative) with us at feedback.SLTC.IHC@dol.gov.

For questions regarding a specific case, please contact the Chromatography Group Manager, or the Spectroscopy and Physical Measurements Group Manager listed at http://intranet.osha.gov/dts/LAP/sltc.html.

Sampling Number: 301406

Permissible Exposure Limit Summary

Office ID	Inspection Number	Sampled Establishment	Sampling Number
418800	1293032	Archer Western Construction, LLC	301406

Analyte Code	Req	Sample Type	Exposure Type	Exposure	Unit	PEL	PEL Severity

The following potentially applicable occupational exposure limits (OELs) are provided for reference only. OELs are not to be cited as OSHA standards. OELs referenced below can be a useful part of identifying the existence of a hazardous condition, but may not be sufficient alone to provide evidence of either hazard recognition or potential means of abatement.

Analyte Code	Req	Sample Type	Exposure Type	Exposure	Unit	REL	REL Severity

Analyte Code	Req	Sample Type	Exposure Type	Exposure	Unit	TLV	TLV Severity

U.S. Department of Commerce
National Oceanic & Atmospheric Administration
National Environmental Satellite, Data, and Information Service
Current Location: Elev: 29 ft. Lat: 25.7881° N Lon: -80.3169° W
Station: **MIAMI INTERNATIONAL AIRPORT, FL US 12839**

Local Climatological Data
Daily Summary
February 2018
Generated on 05/30/2018

National Centers for Environmental Information
151 Patton Avenue
Asheville, North Carolina 28801

Date	Temperature (F)							Degree Days (base 65F)		Sun (LST)		Weather	Precipitation (in)			Pressure (inHg)		Wind	Maximum Wind Speed = MPH / Direction = Degrees			
	Max	Min	Avg	Dep	ARH	ADP	AWB	Heat	Cool	Rise	Set	Weather Type	TLC	Snow Fall	Snow Depth	Avg Stn	Avg SL	Avg Speed	Peak Speed	Peak Dir	Sust. Speed	Sust. Dir
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
01	79	58*	68	-0.9				0	3	0705	1805		0.00			30.14		6.0	20	110	16	110
02	82	64	73	4.0				0	8	0705	1806		0.00			30.12		3.6	15	300	10	110
03	75	67	71	1.9				0	6	0704	1806	RA BR	0.12			30.14		8.8	25	100	21	100
04	80	69	74	4.8				0	9	0704	1807		0.00			30.04		9.8	29	160	18	150
05	84	70	77	7.7				0	12	0703	1808		0.00			30.06		6.2	21	080	17	080
06	79	70	74	4.6				0	9	0703	1809		T			30.19		10.5	19	090	16	090
07	83	72	78	8.5				0	13	0702	1809		T			30.17		10.4	28	120	21	120
08	84	73	78	8.4				0	13	0701	1810		0.00			30.17		9.1	18	090	15	080
09	83	72	78	8.3				0	13	0701	1811	RA BR	0.04			30.16		11.8	25	070	20	100
10	84	72	78	8.2				0	13	0700	1811		T			30.12		12.8	29	120	21	110
11	85	75	80	10.1				0	15	0700	1812		0.00			30.11		13.2	30	120	23	120
12	84	75	80	10.0				0	15	0659	1813		0.00			30.21		11.6	27	140	20	140
13	85	73	79	8.9				0	14	0658	1813		0.00			30.29		11.1	22	120	17	120
14	83	72	78	7.8				0	13	0657	1814		0.00			30.29		10.2	22	110	18	120
15	82	67	74	3.7				0	9	0657	1815		0.00			30.24		5.9	20	100	14	100
16	83	64	74	3.6				0	9	0656	1815		0.00			30.16		4.4	20	160	13	150
17	84	66	75	4.5				0	10	0655	1816		0.00			30.16		5.2	25	170	15	130
18	84	70	77	6.4				0	12	0654	1817		0.00			30.17		9.0	28	090	18	120
19	84	70	77	6.4				0	12	0654	1817	RA BR	0.10			30.19		15.3	29	100	25	090
20	84	73	78	7.3				0	13	0653	1818	RA	T			30.24		17.3	30	120	23	100
21	83	74	78	7.2				0	13	0652	1818		0.00			30.29		16.8	37	090	25	080
22	83	72	78	7.1				0	13	0651	1819	RA BR	0.01			30.29		14.1	28	100	24	100
23	82	72	77	6.0				0	12	0650	1820	RA	0.02			30.26		15.3	27	090	22	080
24	82	71	76	4.9				0	11	0649	1820	RA	T			30.15		13.2	27	100	22	110
25	82	71	76	4.9				0	11	0648	1821		T			30.13		9.9	26	110	16	100
26	84	71	78	6.8				0	13	0648	1821	RA	0.02			30.12		7.1	22	110	15	250
27	85*	68	76	4.7				0	11	0647	1822	RA	0.06			30.12		6.3	24	080	17	090
28	81	70	76	4.6				0	11	0646	1822		0.00			30.06		9.8	20	100	15	100
	82.6	70.0	76.3							Monthly Averages | Totals			0.37			30.17	30.21	10.1				
	4.5	7.7	6.1							Departure from Normal (1981-2010)			-1.88									

Degree Days

	Monthly		Season-to-date	
	Total	Departure	Total	Departure
Heating	0	-26	81	
Cooling	317	146	465	

Number of days with...

	Temperature				Precipitation		Snow	Weather	
	Max		Min						
	>=90°	<=32°	<=32°	<=0°	>=0.01"	>=0.1"	>=1"	T-Storms	Heavy Fog
	0	0	0	0	7	2	0		

Date of 5-sec to 3-sec wind equipment change	Sea Level Pressure			Greatest...		
		Date	Time	24-Hr...		Snow Depth
2009-07-14	Maximum 30.39	13	1105	Precip	Snowfall	
	Minimum 30.00	04	1553	0.12		
				Date		
				03-03		

Station Augmentation

Name:N/A Lat: N/A Lon: N/A Elevation: N/A Distance: N/A Elements: N/A Equipment: N/A

U.S. Department of Commerce
National Oceanic & Atmospheric Administration
National Environmental Satellite, Data, and Information Service
Current Location: Elev: 10 ft. Lat: 25.6475° N Lon: -80.4331° W
Station: **MIAMI KENDALL TAMIAMI EXEC AIRPORT, FL US 12888**

Local Climatological Data
Daily Summary
February 2018

Generated on 05/30/2018

National Centers for Environmental Information
151 Patton Avenue
Asheville, North Carolina 28801

Date	Temperature (F)							Degree Days (base 65F)		Sun (LST)		Weather	Precipitation (in)			Pressure (inHg)		Wind	Maximum Wind Speed = MPH / Direction = Degrees			
	Max	Min	Avg	Dep	ARH	ADP	AWB	Heat	Cool	Rise	Set	Weather Type	TLC	Snow Fall	Snow Depth	Avg Stn	Avg SL	Avg Speed	Peak Speed	Peak Dir	Sust. Speed	Sust. Dir
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
01	79	55*	67	0.4				0	2	0705	1806		0.00			30.16		5.9	22	100	17	100
02	82	60	71	4.2				0	6	0705	1806		0.00			30.14		4.2	16	300	14	300
03	74	59	66	-0.9				0	1	0705	1807	RA	0.02			30.15		9.7	27	090	22	090
04	80	67	74	6.9				0	9	0704	1808		0.00			30.06		8.7	23	120	17	140
05	85	65	75	7.8				0	10	0703	1808	FG	0.00			30.09		6.9	21	060	18	080
06	78	64	71	3.6				0	6	0703	1809		0.00			30.21		9.9	22	100	17	090
07	82	68	75	7.5				0	10	0702	1810		T			30.19		10.1	23	130	20	100
08	84	67	76	8.3				0	11	0702	1811		0.00			30.19		9.1	21	100	17	100
09	82	67	74	6.2				0	9	0701	1811		0.00			30.18		11.5	28	120	23	100
10	83	72	78	10.0				0	13	0700	1812	RA	0.01			30.14		11.2	26	120	22	120
11	84	73	78	9.9				0	13	0700	1813		0.00			30.12		12.5	30	140	22	140
12	84	72	78	9.8				0	13	0659	1813		0.00			30.22		10.1	23	120	18	120
13	84	68	76	7.7				0	11	0658	1814	RA	0.01			30.31		11.1	23	110	18	100
14	83	66	74	5.6				0	9	0658	1815	RA	T			30.32		8.9	24	090	17	110
15	82	60	71	2.5				0	6	0657	1815		0.00			30.26		4.5	19	110	14	100
16	84	57	70	1.4				0	5	0656	1816		0.00			30.18		3.3	22	160	13	130
17	83	60	72	3.3				0	7	0655	1816		0.00			30.18		4.7	23	130	15	120
18	83	62	72	3.2				0	7	0655	1817		0.00			30.19		7.9	24	110	18	090
19	82	70	76	7.1				0	11	0654	1818	RA BR	0.09			30.21		13.5	30	100	26	100
20	82	73	78	9.0				0	13	0653	1818	RA	0.12			30.26		14.9	30	100	24	110
21	84	73	78	9.0				0	13	0652	1819		0.00			30.30		15.9	31	080	24	090
22	84	71	78	8.9				0	13	0651	1820	RA	0.11			30.31		14.9	28	100	23	100
23	83	70	76	6.9				0	11	0651	1820	RA	0.12			30.27		13.8	27	100	22	090
24	82	70	76	6.8				0	11	0650	1821		T					12.7	26	100	22	110
25	84	69	76	6.8				0	11	0649	1821		Ts					8.2	22	130	17	110
26	83s	63	73s	3.7s				0s	8s	0648	1822	RA BR	0.54			30.14		3.7	21	020	16	280
27	85*	64	74	4.7				0	9	0647	1822	RA BR	0.16			30.14		5.7	25	090	17	100
28	82	64	73	3.7				0	8	0646	1823		0.00			30.08		7.9	20	100	16	110
	82.4	66.0	74.2							Monthly Averages | Totals			1.18s			30.19	30.20	9.4				
	4.0	7.8	5.9	Departure from Normal (1981-2010)									-1.32s									

Degree Days

	Monthly		Season-to-date	
	Total	Departure	Total	Departure
Heating	0	-36	146	
Cooling	258	130	365	

Number of days with...

	Temperature				Precipitation		Snow	Weather	
	Max		Min						
	>=90°	<=32°	<=32°	<=0°	>=0.01"	>=0.1"	>=1"	T-Storms	Heavy Fog
	0	0	0	0	9	5			

Date of 5-sec to 3-sec wind equipment change	Sea Level Pressure			Greatest...		
		Date	Time	24-Hr...		Snow Depth
2009-08-13	Maximum 30.38	14	1027	Precip	Snowfall	
	Minimum 29.99	04	1617	0.54		
				Date		
				26-26		

Station Augmentation

Name:N/A Lat: N/A Lon: N/A Elevation: N/A Distance: N/A Elements: N/A Equipment: N/A

U.S. Department of Commerce
National Oceanic & Atmospheric Administration
National Environmental Satellite, Data, and Information Service
Current Location: Elev: 10 ft. Lat: 25.9069° N Lon: -80.2803° W
Station: **MIAMI OPA LOCKA AIRPORT, FL US 12882**

Local Climatological Data
Daily Summary
February 2018
Generated on 05/30/2018

National Centers for Environmental Information
151 Patton Avenue
Asheville, North Carolina 28801

Date	Temperature (F)							Degree Days (base 65F)		Sun (LST)		Weather	Precipitation (in)			Pressure (inHg)		Wind	Maximum Wind Speed = MPH / Direction = Degrees			
	Max	Min	Avg	Dep	ARH	ADP	AWB	Heat	Cool	Rise	Set	Weather Type	TLC	Snow Fall	Snow Depth	Avg Stn	Avg SL	Avg Speed	Peak Speed	Peak Dir	Sust. Speed	Sust. Dir
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
01	78	56*	67	-0.9				0	2	0705	1805		0.00			30.17		5.0	21	100	16	130
02	82	60	71	3.0				0	6	0705	1805		0.00			30.15		4.5	20	300	14	290
03	74	65	70	1.9				0	5	0704	1806	RA BR	0.08			30.16		11.5	25	070	22	080
04	80	68	74	5.8				0	9	0704	1807		0.00			30.08		10.1	24	160	18	170
05	84	68	76	7.7				0	11	0703	1808		0.00			30.09		8.0	23	080	17	050
06	79	65	72	3.6				0	7	0703	1808		0.00			30.22		8.5	20	100	16	110
07	82	70	76	7.5				0	11	0702	1809		0.00			30.20		9.9	25	130	21	110
08	84	67	76	7.4				0	11	0701	1810		0.00			30.21		7.7	19	060	16	080
09	83	70	76	7.3				0	11	0701	1810	RA	T			30.19		10.2	26	090	21	120
10	83	71	77	8.2				0	12	0700	1811		0.00			30.16		11.4	26	140	21	130
11	84	74	79	10.1				0	14	0700	1812	RA	T			30.14		13.8	27	140	22	140
12	83	74s	78s	9.0s				0s	13s	0659	1812								20	120	15	120
13	84	71	78	8.9				0	13	0658	1813		0.00			30.33		10.1	21	100	17	120
14	83	70	76	6.8				0	11	0657	1814								28	100	15	100
15	82	63	72	2.7				0	7	0657	1814		0.00			30.27		5.1	20	110	14	110
16	83	60	72	2.6				0	7	0656	1815		0.00			30.19		4.2	17	190	14	150
17										0655	1816		0.00			30.19			21	150	16	110
18	84	67	76	6.4				0	11	0654	1816		0.00			30.20		7.8	24	090	17	090
19	82	70	76	6.3				0	11	0654	1817	RA	0.02			30.22		14.2	28	080	24	090
20	85	74	80	10.3				0	15	0653	1817		T			30.27		15.4	29	100	22	130
21	84	74	79	9.2				0	14	0652	1818	RA	T			30.32		15.1	28	110	24	090
22	83	74	78	8.1				0	13	0651	1819		T			30.32		13.6	27	090	22	080
23	83	71	77	7.0				0	12	0650	1819	RA	T			30.28		13.8	26	110	22	090
24	84	72	78	7.9				0	13	0649	1820	RA	T			30.19		12.5	27	090	22	130
25	84	68	76	5.8				0	11	0648	1820		T			30.15		8.8	22	140	18	140
26	86*	69	78	7.7				0	13	0648	1821	RA	T			30.15		6.0	19	160	14	140
27	85	67	76	5.6				0	11	0647	1822	RA	0.02			30.16		8.1	25	080	20	080
28	82	68	75	4.5				0	10	0646	1822	RA	T			30.09		7.7	22	050	17	060
	83.6	69.1	76.4							Monthly Averages | Totals			0.04s			30.22	30.23	9.6				
	5.6	8.7	7.2							Departure from Normal (1981-2010)			-2.45s									

Degree Days

	Monthly		Season-to-date	
	Total	Departure	Total	Departure
Heating	0	-30	115	
Cooling	283	136	393	

Number of days with...

Temperature				Precipitation		Snow	Weather	
Max		Min						
>=90°	<=32°	<=32°	<=0°	>=0.01"	>=0.1"	>=1"	T-Storms	Heavy Fog
				2	0			

Date of 5-sec to 3-sec wind equipment change	Sea Level Pressure				Greatest...		
			Date	Time	24-Hr...		Snow Depth
2009-07-08	Maximum	30.38s	22	1041	Precip	Snowfall	
	Minimum	30.06s	28	1747	0.02		
					Date		
					27-28		

Station Augmentation

Name:N/A Lat: N/A Lon: N/A Elevation: N/A Distance: N/A Elements: N/A Equipment: N/A