

NWS FORM E-5 (11-88) (PRES. by NWS Instruction 10-924)	U.S. DEPARTMENT OF COMMERCE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION NATIONAL WEATHER SERVICE	HYDROLOGIC SERVICE AREA (HSA)	
		Tulsa, Oklahoma (TSA)	
MONTHLY REPORT OF RIVER AND FLOOD CONDITIONS		REPORT FOR:	
		MONTH March	YEAR 2021
TO: Hydrometeorological Information Center, W/OH2 NOAA / National Weather Service 1325 East West Highway, Room 7230 Silver Spring, MD 20910-3283		SIGNATURE Steven F. Piltz (Meteorologist-in-Charge)	
		DATE April 15, 2021	

When no flooding occurs, include miscellaneous river conditions, such as significant rises, record low stages, ice conditions, snow cover, droughts, and hydrologic products issued (NWS Instruction 10-924)

An "X" in the box indicates no flood stages were reached in this Hydrologic Service Area (HSA) during the month above.

Heavy rain across northeast OK mid-month resulted in minor to moderate flooding. Elsewhere, rainfall was below normal for March 2021. Normal precipitation for March ranges from 3.1 inches in Pawnee County to 4.3 inches in Le Flore County. In the Ozark region of northwest Arkansas, the normal precipitation for the month is 4.4 inches. This report, past E-5 reports, and monthly hydrology and climatology summaries can be found at <http://www.weather.gov/tsa/hydro-monthly-summary>.

Monthly Summary

Using the radar-derived estimated observed precipitation from the RFCs (Fig. 1a), rainfall totals for March 2021 ranged from around 1.50" to around 10" across eastern OK and northwest AR, with much of the area receiving 2"-4". The heaviest rainfall occurred primarily across the counties that border KS and MO, where the rainfall was 100%-300% of normal March rainfall. For the remainder of the area, the rainfall totals correspond to 25% to 90% of the normal March rainfall (Fig. 1b).

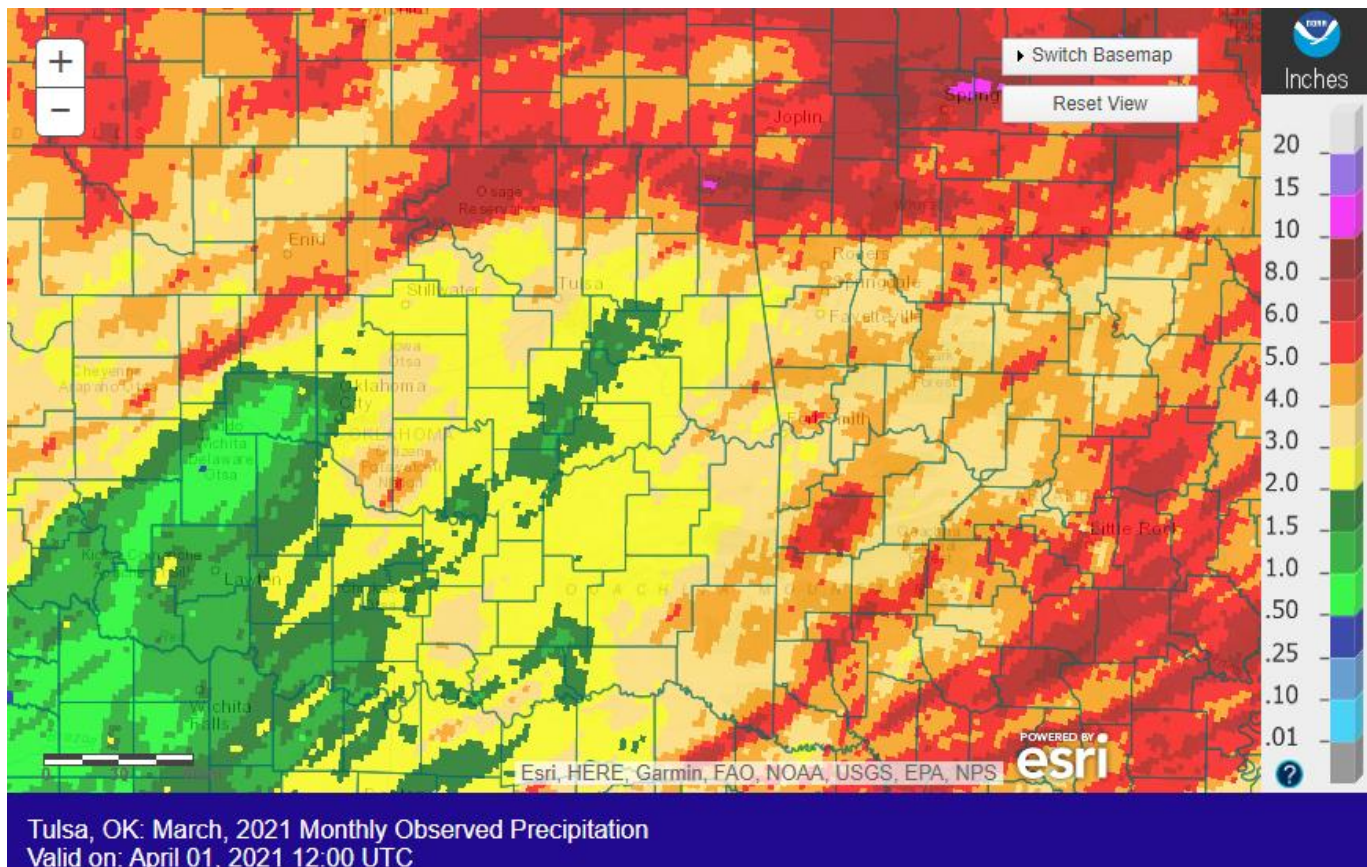
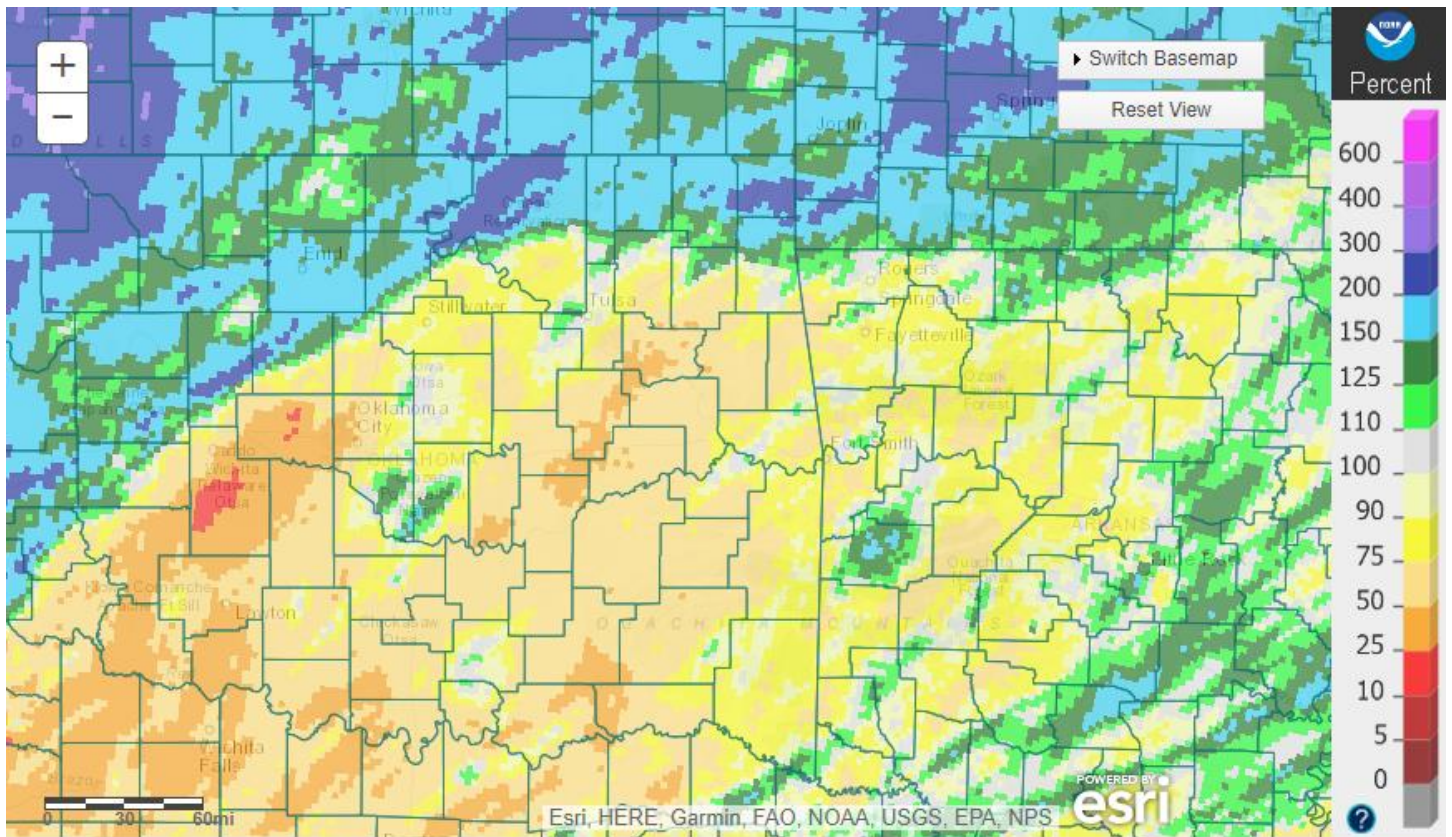


Fig. 1a. Estimated Observed Rainfall for March 2021



Tulsa, OK: March, 2021 Monthly Percent of Normal Precipitation
Valid on: April 01, 2021 12:00 UTC

Fig. 1b. Estimated % of Normal Rainfall for March 2021

In Tulsa, OK, March 2021 ranked as the 16th warmest March (55.4°F, tied 1918; since records began in 1905) and the 52nd wettest March (3.29"; since records began in 1888). Fort Smith, AR had the 16th warmest March (56.8°F, tied 2004; since records began in 1883) and the 55th wettest March (3.61"; since records began in 1883). Fayetteville, AR had the 10th warmest (52.1°F, tied 1982) and the 32nd driest (3.35") March since records began in 1950.

Some of the larger precipitation reports (in inches) for March 2021 included:

Foraker, OK (meso)	8.06	Burbank, OK (meso)	7.59	Ochelata 5.6N, OK (coco)	7.01
Vinita, OK (meso)	6.86	Wyandotte 7.3NE, OK (coco)	6.79	Copan, OK (meso)	6.53
Miami, OK (meso)	6.07	Bella Vista 2.2E, AR (coco)	6.01	Nowata, OK (meso)	5.94

Some of the lowest precipitation reports (in inches) for March 2021 included:

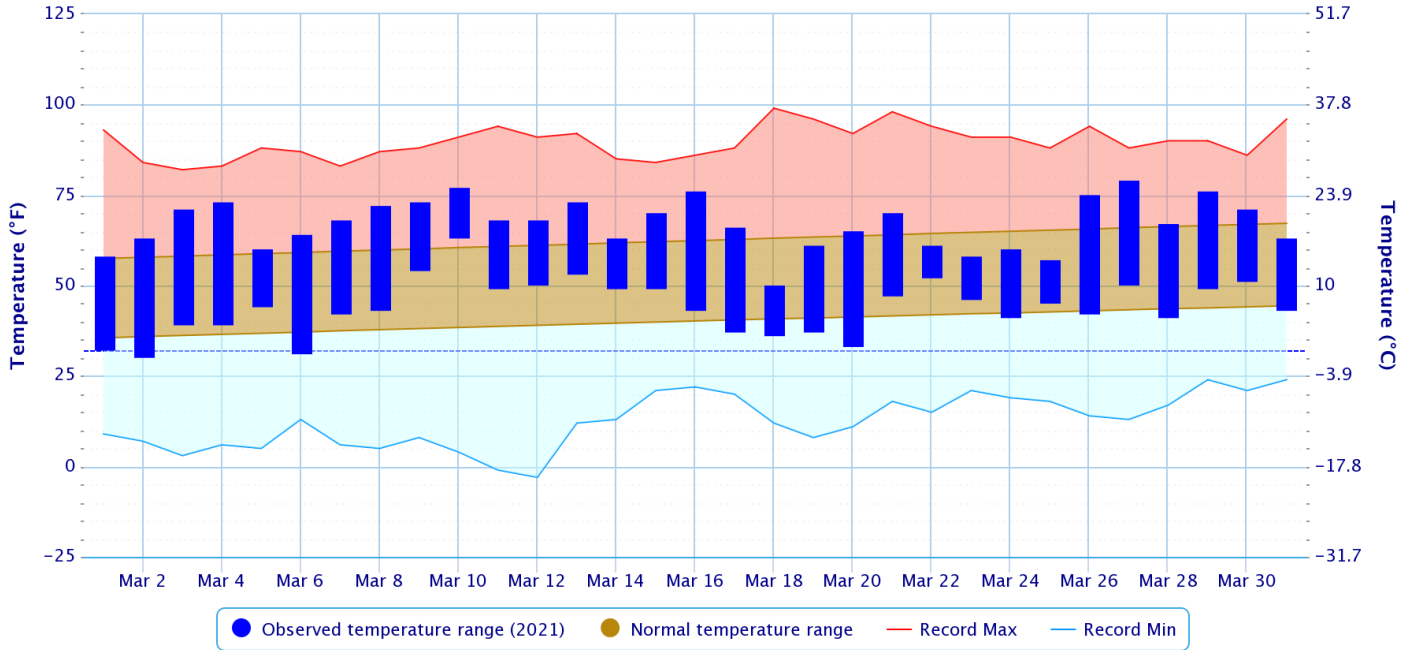
Haskell, OK (meso)	1.64	Okmulgee, OK (meso)	1.71	Porter, OK (meso)	1.77
McAlester, OK (ASOS)	1.92	Eufaula, OK (meso)	1.97	Tulsa 7.7SSE, OK (coco)	2.01
Bixby, OK (meso)	2.10	Okemah, OK (meso)	2.12	Clayton, OK (meso)	2.24

According to statistics from the [Oklahoma Climatological Survey \(OCS\) Mesonet](#):

Rank since 1921	March 2021	Last 60 Days (Jan 31 – Mar 31)	Year-to-Date (Jan 1 – Mar 31)	Last 120 Days (Dec 2 – Mar 31)	Water Year-to-Date (Oct 1, 2020 – Mar 31, 2021)	Last 365 Days (Apr 1, 2020 – Mar 31, 2021)
Northeast OK	18 th wettest	42 nd wettest	22 nd wettest	16 th wettest	21 st wettest	39 th wettest
East Central OK	40 th driest	21 st driest	28 th driest	44 th driest	36 th driest	35 th wettest
Southeast OK	40 th driest	30 th driest	30 th driest	50 th wettest	30 th driest	28 th wettest
Statewide	31 st wettest	43 rd driest	51 st wettest	36 th wettest	46 th wettest	47 th wettest

Daily Temperature Data – Tulsa Area, OK (ThreadEx)

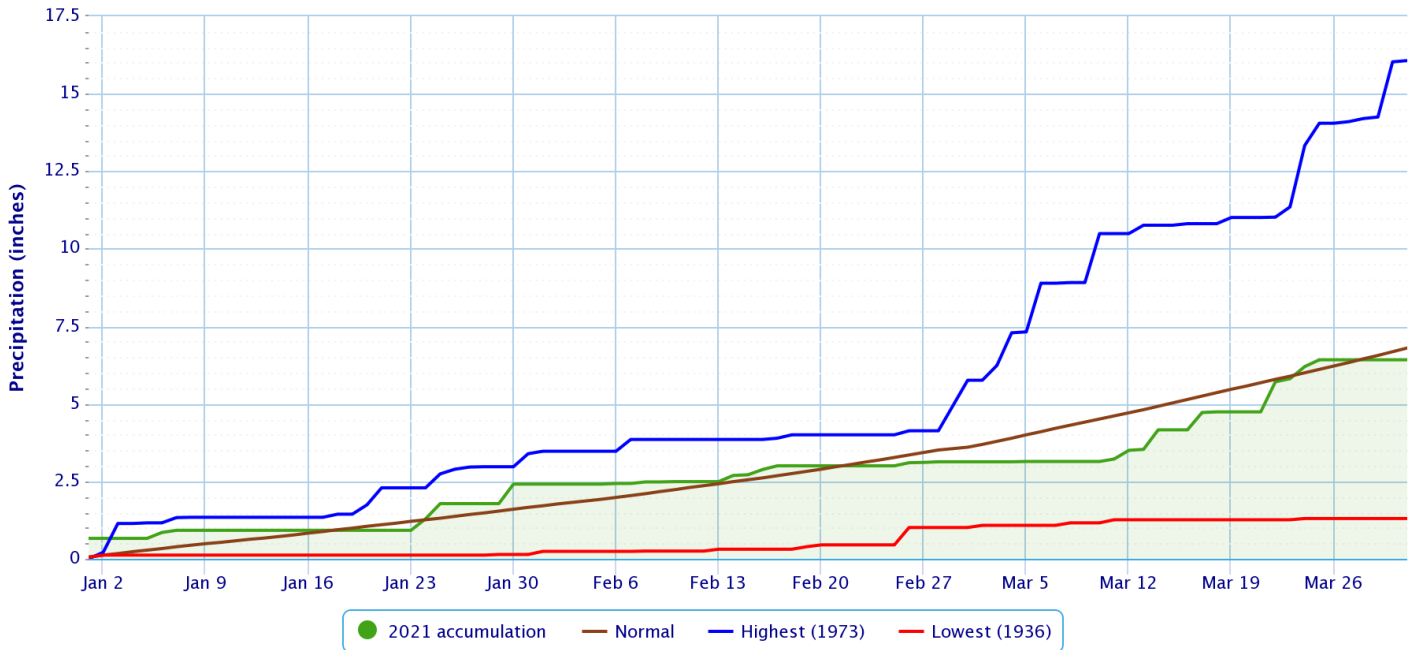
Period of Record – 1905-01-06 to 2021-04-11. Normals period: 1981-2010. Click and drag to zoom chart.



Powered by ACIS

Accumulated Precipitation – Tulsa Area, OK (ThreadEx)

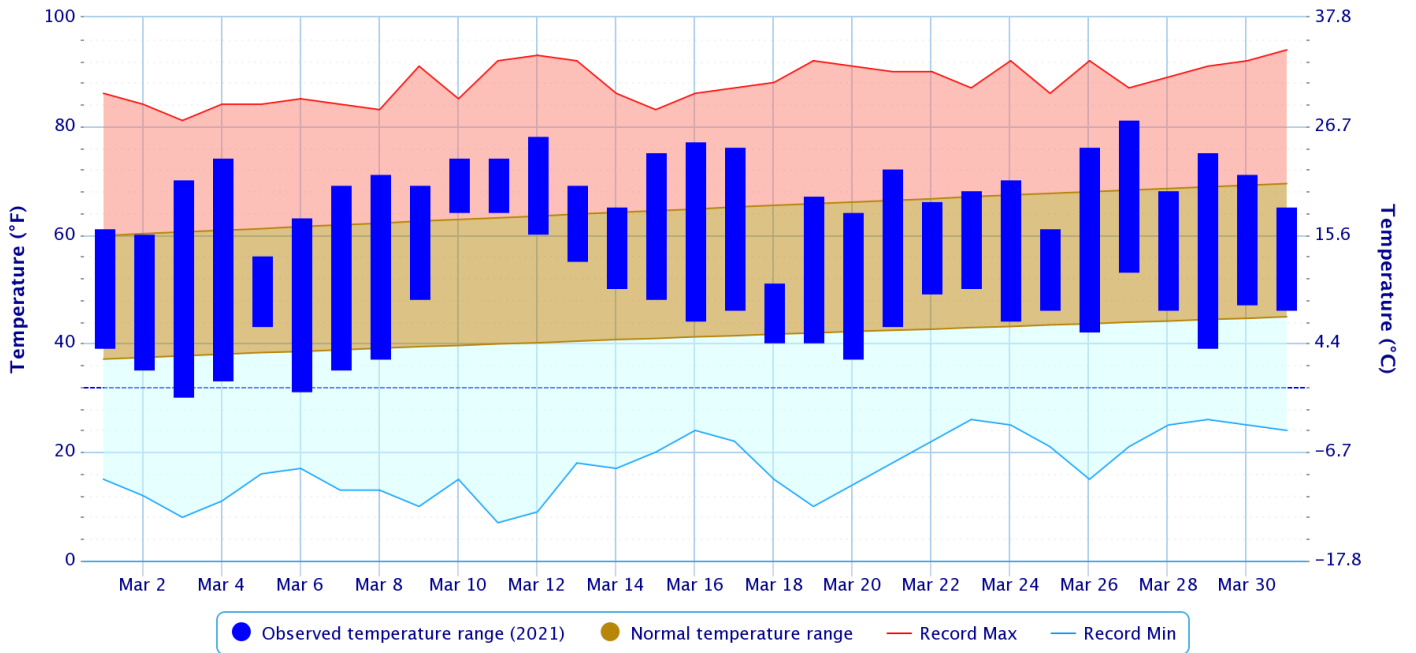
Click and drag to zoom to a shorter time interval; green/black diamonds represent subsequent/missing values



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Daily Temperature Data – Fort Smith Area, AR (ThreadEx)

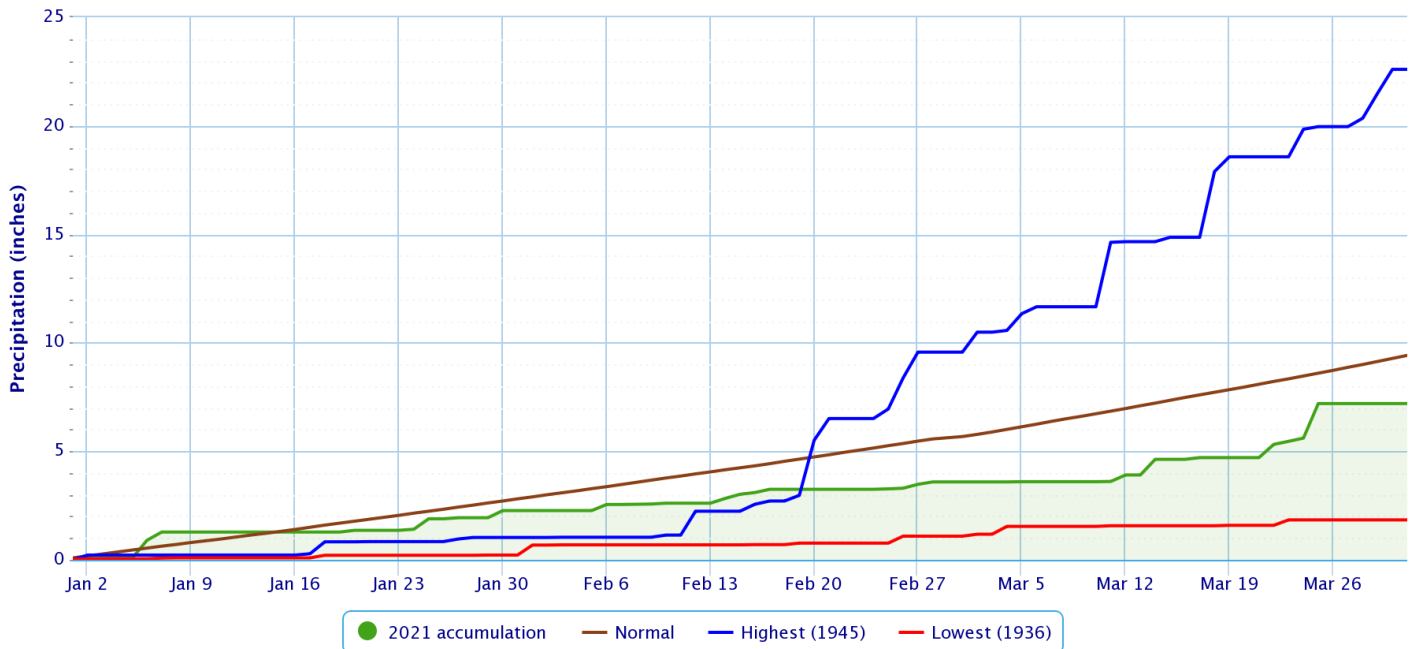
Period of Record – 1882-06-01 to 2021-04-11. Normals period: 1981-2010. Click and drag to zoom chart.



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Accumulated Precipitation – Fort Smith Area, AR (ThreadEx)

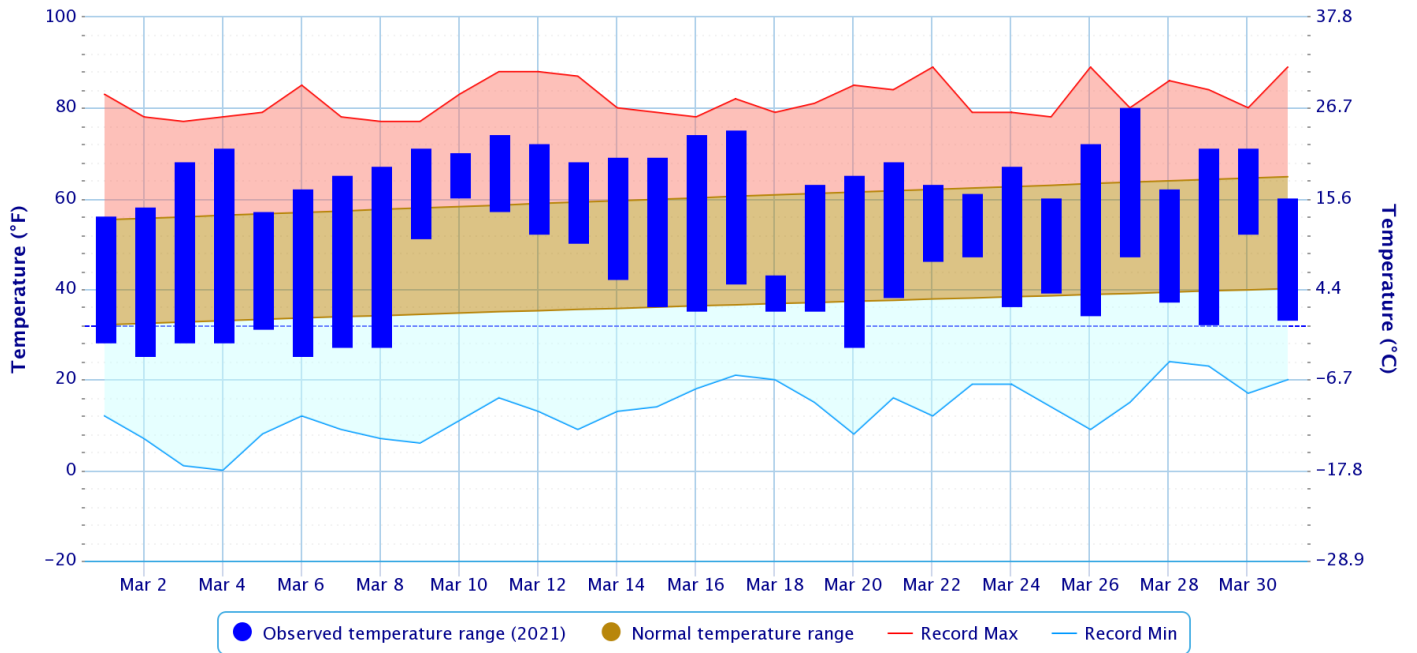
Click and drag to zoom to a shorter time interval; green/black diamonds represent subsequent/missing values



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Daily Temperature Data – FAYETTEVILLE DRAKE FIELD, AR

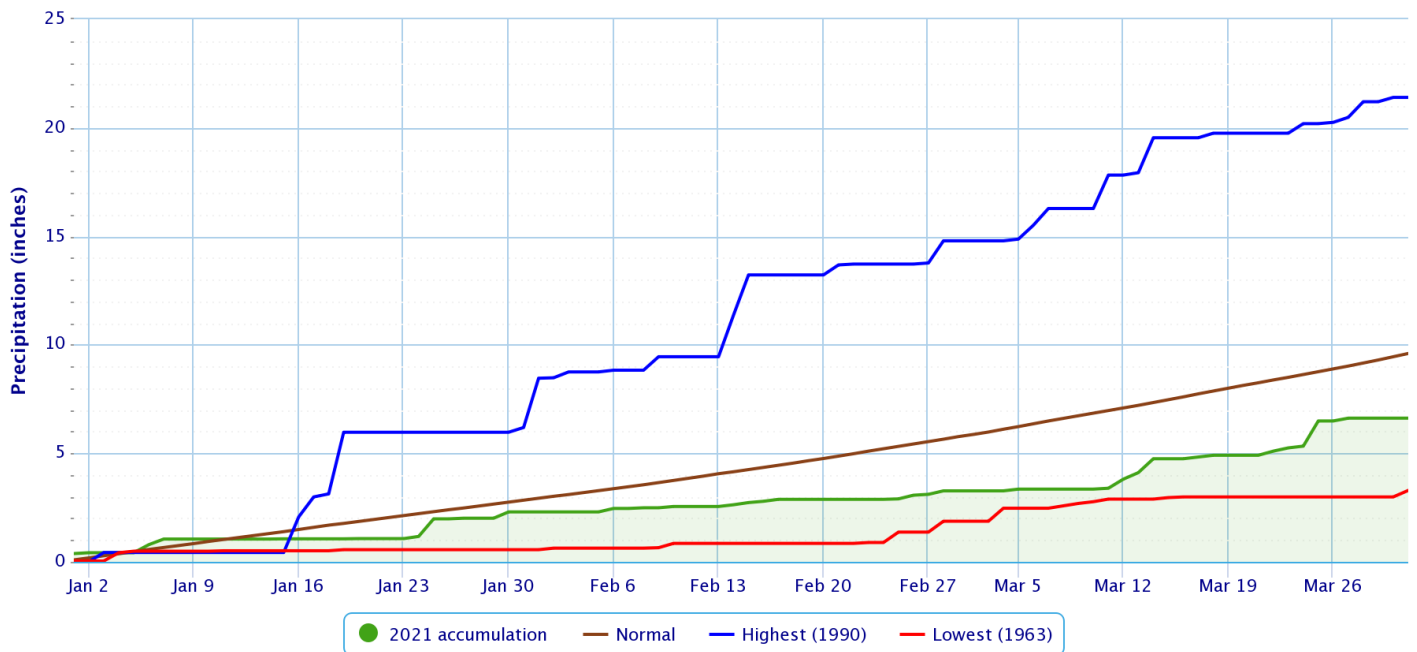
Period of Record – 1949-07-14 to 2021-04-11. Normals period: 1981-2010. Click and drag to zoom chart.



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Accumulated Precipitation – FAYETTEVILLE DRAKE FIELD, AR

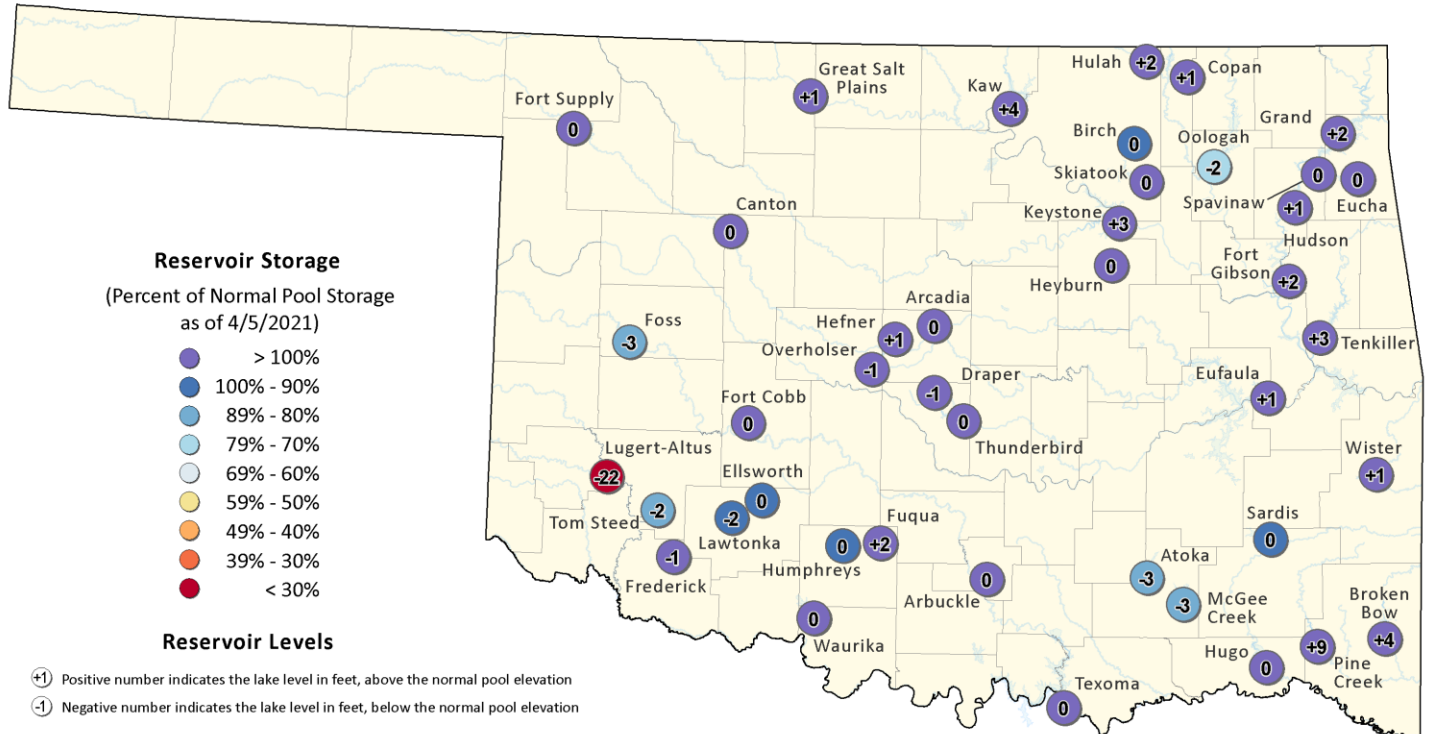
Click and drag to zoom to a shorter time interval; green/black diamonds represent subsequent/missing values



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Reservoirs

Oklahoma Surface Water Resources
Reservoir Levels and Storage as of 4/5/2021



This map shows reservoir storage as a percentage of normal pool storage capacity. The source information was collected from real-time lake gages monitored by the U.S. Army Corps of Engineers (http://www.svt-wc.usace.army.mil/Daily_Morning_Reservoir_Report.pdf), and the U.S. Geological Survey (http://waterdata.usgs.gov/ok/nwis/current/?type=lake&group_key=basin_cd) For more information please visit the OWRB's website at: (<http://www.owrb.ok.gov>)



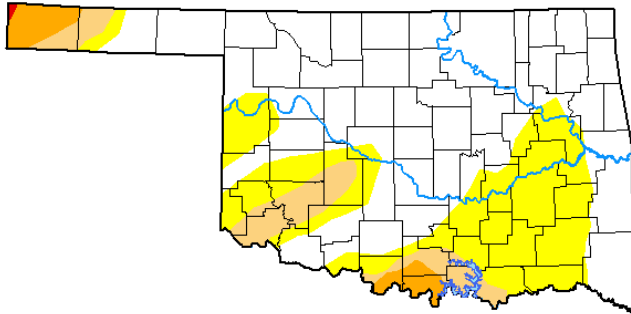
According to the USACE, many of the lakes in the HSA were higher than 3% of top of their conservation pools as of 4/01/2021: Beaver Lake 23%, Grand Lake 19%, Keystone Lake 11%, Lake Eufaula 11%, Kaw Lake 8%, Hulah Lake 8%, Tenkiller Lake 8%, Copan Lake 5%, Fort Gibson Lake 5%, and Wister Lake 4%. One lake was operating below 3% of the top of its conservation pool: Oologah Lake 90%.

Drought

According to the [U.S. Drought Monitor](#) (USDM) from March 2, 2021 (Figs. 3a, 3b), no drought conditions were present across eastern OK and northwest AR. Abnormally Dry (but not in drought) conditions were occurring in a portion of Wagoner, Okmulgee, McIntosh, Muskogee, Pittsburg, Haskell, Latimer, Pushmataha, and Choctaw Counties in eastern OK.

U.S. Drought Monitor Oklahoma

March 30, 2021
(Released Thursday, Apr. 1, 2021)
Valid 8 a.m. EDT



Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	63.05	36.95	10.71	3.42	0.08	0.00
Last Week 03-23-2021	63.26	36.74	11.54	3.42	0.08	0.00
3 Months Ago 12-29-2020	56.83	43.17	25.21	7.75	1.45	0.00
Start of Calendar Year 12-29-2020	56.83	43.17	25.21	7.75	1.45	0.00
Start of Water Year 09-29-2020	66.79	33.21	17.71	11.97	1.55	0.00
One Year Ago 03-31-2020	95.89	4.11	2.52	0.84	0.00	0.00

Intensity:
 None (white) D2 Severe Drought (dark orange)
 D0 Abnormally Dry (yellow) D3 Extreme Drought (red)
 D1 Moderate Drought (orange) D4 Exceptional Drought (dark red)

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. For more information on the Drought Monitor, go to <https://droughtmonitor.unl.edu/About.aspx>

Author:
Brad Pugh
CPC/NOAA

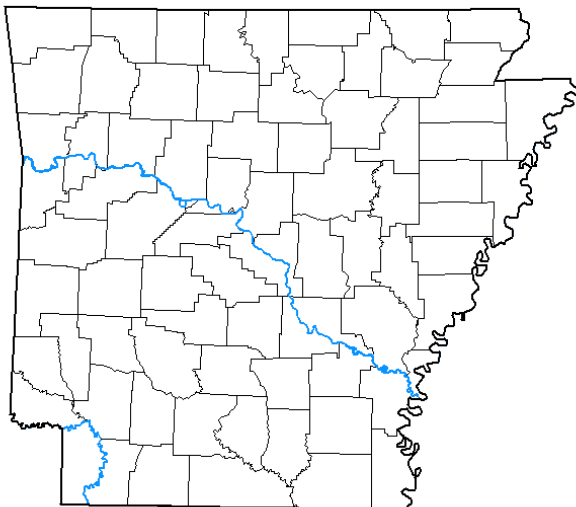


droughtmonitor.unl.edu

Fig. 3a. Drought Monitor for Oklahoma

U.S. Drought Monitor Arkansas

March 30, 2021
(Released Thursday, Apr. 1, 2021)
Valid 8 a.m. EDT



Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	100.00	0.00	0.00	0.00	0.00	0.00
Last Week 03-23-2021	100.00	0.00	0.00	0.00	0.00	0.00
3 Months Ago 12-29-2020	16.45	83.55	6.87	0.00	0.00	0.00
Start of Calendar Year 12-29-2020	16.45	83.55	6.87	0.00	0.00	0.00
Start of Water Year 09-29-2020	96.07	3.93	0.62	0.00	0.00	0.00
One Year Ago 03-31-2020	100.00	0.00	0.00	0.00	0.00	0.00

Intensity:
 None (white) D2 Severe Drought (dark orange)
 D0 Abnormally Dry (yellow) D3 Extreme Drought (red)
 D1 Moderate Drought (orange) D4 Exceptional Drought (dark red)

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. For more information on the Drought Monitor, go to <https://droughtmonitor.unl.edu/About.aspx>

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CPC/NOAA



droughtmonitor.unl.edu

Fig. 3b. Drought Monitor for Arkansas

Outlooks

The [Climate Prediction Center](#) (CPC) outlook for April 2021 (issued March 31, 2021) indicates a greatly enhanced chance for above normal temperatures and an equal chance for above, near, and below median precipitation across all of eastern OK and northwest AR. This outlook was largely based on dynamical model output combined with the influence from La Niña and the Madden-Julian Oscillation (MJO).

For the 3-month period April-May-June 2021, CPC is forecasting a greatly enhanced chance for above normal temperatures across all of eastern OK and northwest AR, a slightly enhanced chance for below median precipitation across southeast OK, and an equal chance for above, near, and below median precipitation across the remainder of eastern OK and northwest AR (outlook issued March 18, 2021). This outlook is based on La Niña impacts and long-term trends, as well as incorporating both statistical and dynamical forecast tools. According to CPC, the combined effect of the ocean-atmosphere system is consistent with La Niña conditions during March. There is a likely transition of La Niña to ENSO-neutral conditions over the next month, with an 80% chance of ENSO-neutral during May through July. CPC continues the La Niña Advisory.

Summary of Heavy Precipitation Events Daily quality-controlled rainfall maps can be found at: http://water.weather.gov/precip/index.php?location_type=wfo&location_name=tsa

A stationary front was located from near McAlester to Sallisaw to Fayetteville early on the 12th. Showers and isolated thunderstorms developed north of the front, primarily over southern KS, through the morning and early afternoon hours. The front slowly drifted northward to near I-44 by afternoon. A deep plume of sub-tropical moisture was streaming into the area from the southwest, with precipitable water (PWAT) values near 1.5", which was 3 standard deviations above normal. As the low-level jet began to strengthen during the evening, showers and thunderstorms developed near and north of the stationary front, with widely scattered showers to the south. Storms continued to regenerate along and north of the boundary through the overnight hours, training over the same areas of northeast OK, southeast KS, and northwest AR, before coming to an end late morning of the 13th as the front lifted north. A large swath of 1.5"-4" of rain fell from near Ponca City to Miami (Figs. 4, 5). Much of Ottawa County received 2"-5" of rain, with 5"-8" of rain falling over the central portion of the county. Extensive flash flooding occurred in Ottawa County, and moderate flooding occurred along the Neosho River near Commerce (see preliminary hydrographs at the end of this report and the E3 Report for details). A large area of 3"-6" of rain fell over western and central Osage County, resulting in a fast rise and moderate flooding along Bird Creek at Avant (see preliminary hydrographs at the end of this report and the E3 Report for details). Rises also occurred downstream on Bird Creek, as well as along the Caney River, Verdigris River, and Spring River.

A line of showers and isolated thunderstorms moved east out of central OK/KS and into northeast OK and southeast KS around sunrise on the 14th. This activity moved quickly northeast into MO, while a secondary line of showers and isolated thunderstorms developed across eastern OK near a Pacific front at mid-morning. This activity continued to spread eastward into western AR through the afternoon hours, and finally shifted east of the area by late evening. All of this activity brought another 0.30" to around 1" of rain to most of eastern OK and northwest AR (Figs. 6, 7). These two rainfall events combined brought 3"-8" of rain to northeast OK (Fig. 8), with the additional rain causing the Caney River to exceed flood stage near Ramona and Collinsville, and prolonging the crest along the Neosho River near Commerce (see preliminary hydrographs at the end of this report and the E3 Report for details).

A strong, compact upper-level low exited onto the front range late on the 16th. Ahead of the low in the warm sector, there was a surge of moisture under a broad area of strong synoptic ascent associated with a strong 500 mb jet across OK. Convection triggered close to the low/warm front intersection in northwest OK and then quickly moved east northeast into KS, north central OK, and portions of Osage and Pawnee Counties after midnight on the 17th. These storms continued to move to the east, impacting locations along and north of I-44 during the pre-dawn hours. Additionally, isolated supercells developed soon after midnight over southeast OK and west central AR near a warm front. A third area of showers and thunderstorms developed as a narrow line over eastern OK just before sunrise. Scattered storms then impacted eastern OK and northwest AR through mid-morning from all three sources of convection, before shifting east of the area. Locations northwest of I-44 received 0.25" to around 2" of rain (Figs. 9, 10), with the highest totals occurring across eastern Kay and northwest Osage Counties. The supercells in LeFlore and Sebastian Counties brought 0.25" to near 1.5" of rain.

Convection renewed during the afternoon of the 17th over northeast OK and northwest AR as a surface low near McAlester lifted northeast into the Ozarks. This activity lifted north of the region by mid-evening. Wrap around showers brought some additional rain to northeast OK and northwest AR during the evening and overnight hours as the main upper-level low moved across the region. This activity moved east of the area by sunrise on the 18th. Rainfall totals generally along and north of Highway 412 were 0.25" to around 1.5" (Fig. 11). The multiple rounds of rainfall on the 17th resulted in a second rise on the river systems across northeast OK, with another moderate flood along Neosho River near Commerce (see preliminary hydrographs at the end of this report and the E3 Report for details). As lake levels rose, increase flow from area reservoirs caused a rise along the Arkansas River, remaining near but below flood stage near Muskogee.

Scattered showers and thunderstorms moved into eastern OK after noon on the 22nd as a mid-level low moved out of the southern Rockies and into the Plains. A quasi-linear convective system (QLCS) that had developed along the dry line in west TX moved into eastern OK during the evening, quickly moving east across northwest AR before exiting the area during the overnight hours. Additional showers and thunderstorms moved across a portion of northeast OK after midnight as the main mid-level low passed. This activity ended by sunrise on the 23rd. Rainfall totals ranged from 0.10" to near 2" (Fig. 12).

Low-level moisture surged northward during the evening of the 24th ahead of a compact shortwave over AZ/NM. Showers and thunderstorms developed over central OK and northern TX, which then spread eastward into eastern OK and northwest AR during the late evening hours. This first wave of precipitation moved east of the NWS Tulsa forecast area by 3 am on the 25th, just as a second wave of convection began to move into southeast OK out of TX. This activity continued to spread northeast across eastern OK and northwest AR, south of I-44, through the morning hours. The storm system finally moved east of the area by mid-afternoon. Rainfall totals ranged from 0.25" to near 3", with the highest totals across southeast OK and west central AR (Figs. 13, 14). This rainfall caused a rise to just below flood stage along the Poteau River near Panama, as well as rises above action stage along the Arkansas River near Muskogee and at Ozark L&D (see preliminary hydrographs at the end of this report).

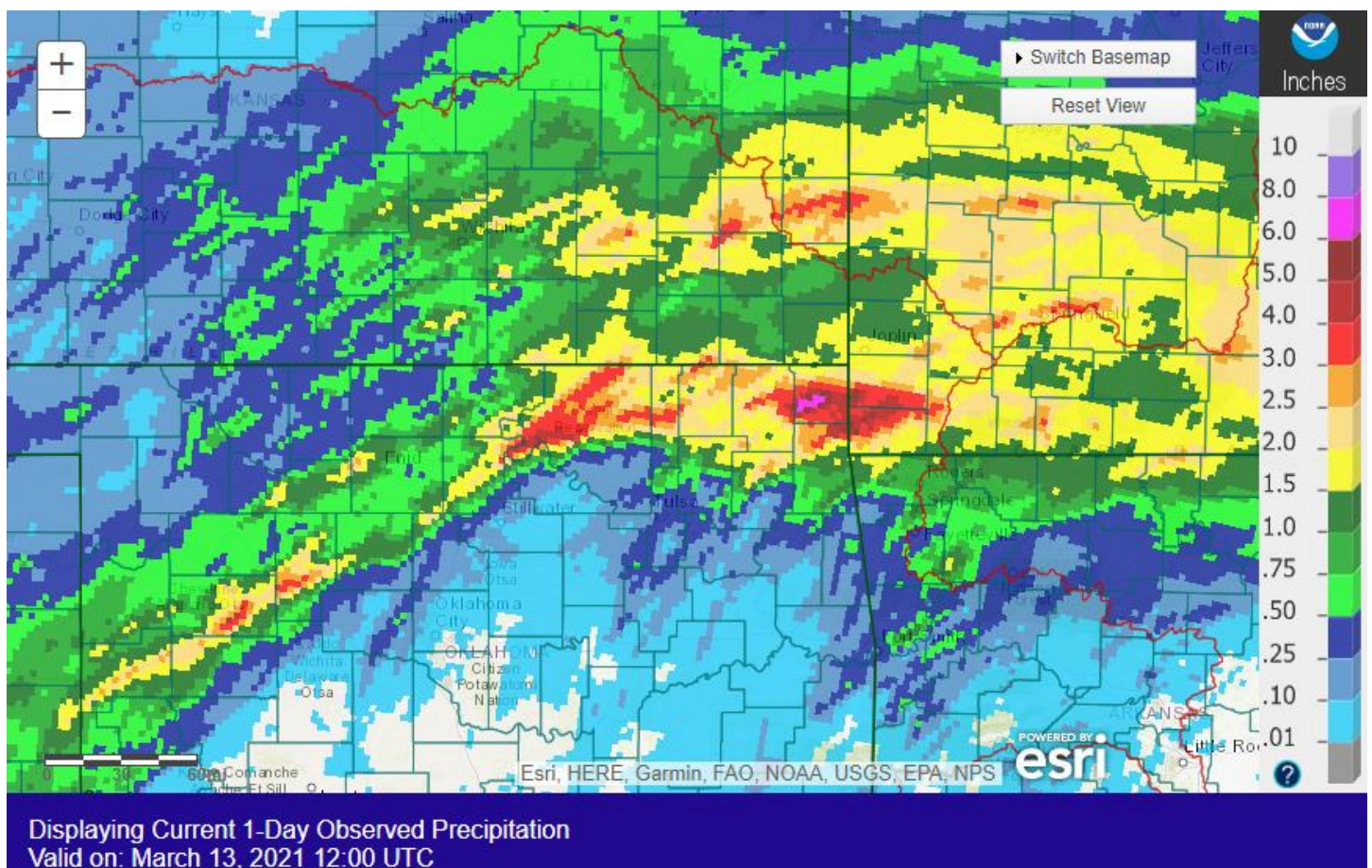
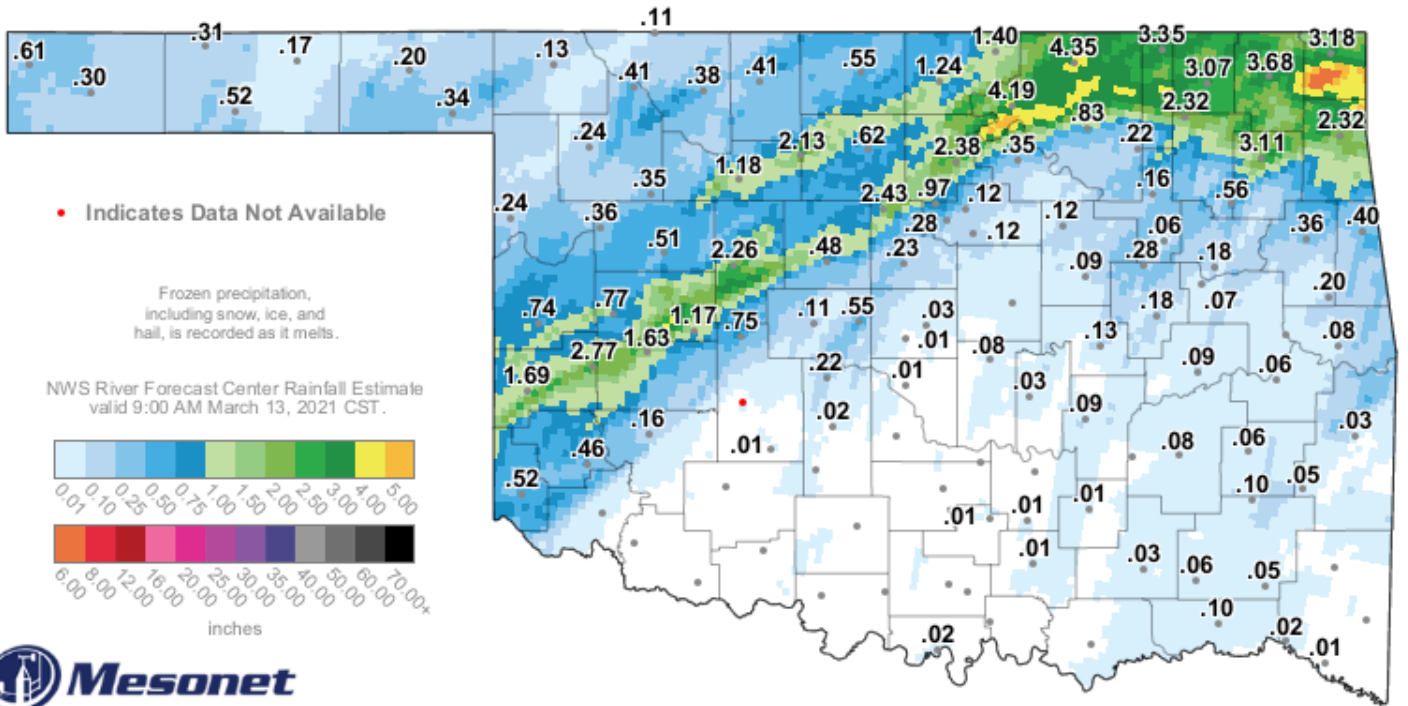


Fig. 4. 24-hour Estimated Observed Rainfall ending at 6am CST 03/13/2021.

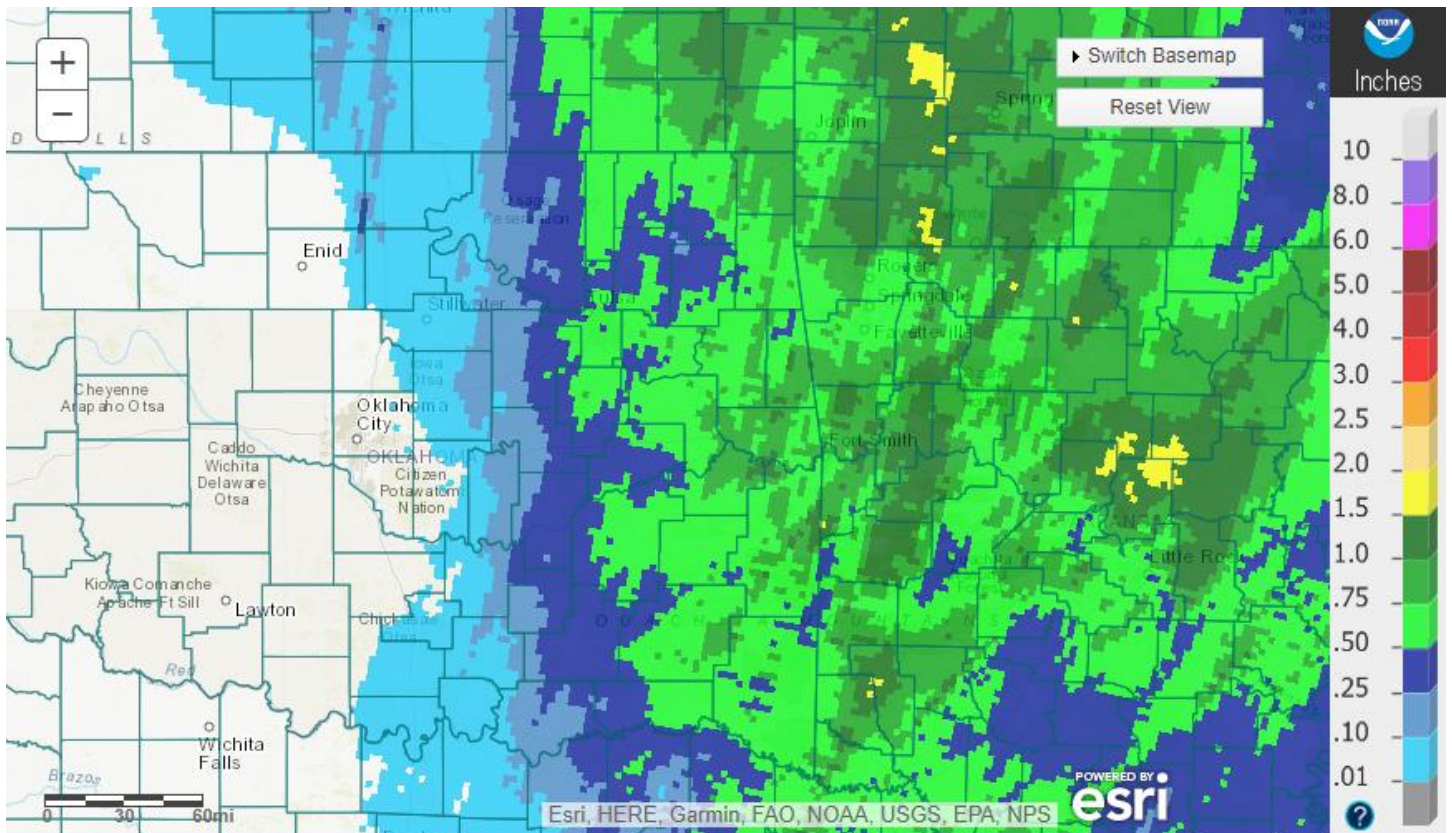


24-Hour Rainfall Accumulation (inches)

10:25 AM March 13, 2021 CST

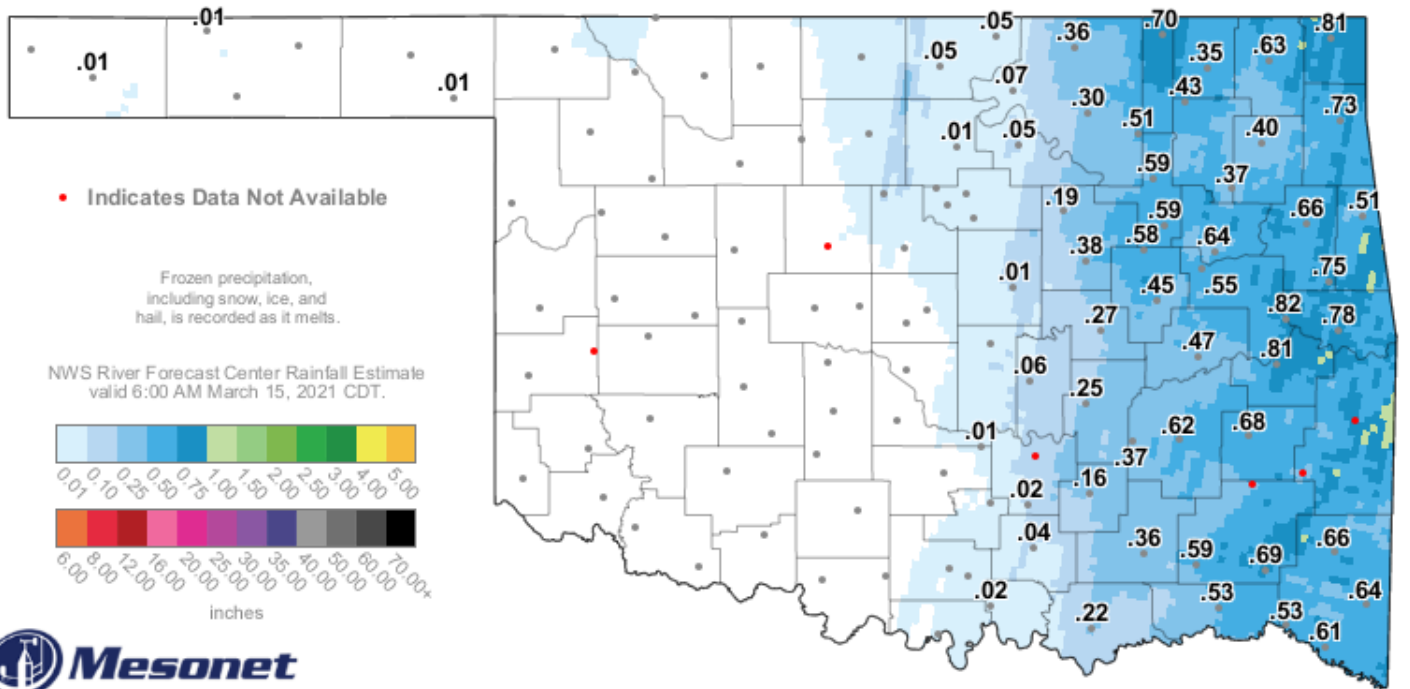
Created 10:30:01 AM March 13, 2021 CST. © Copyright 2021

Fig. 5. OK Mesonet (values) and NWS RFC rainfall estimate (image) 24-hour rainfall ending at 10:25 am CST 03/13/2021.



Tulsa, OK: March 15, 2021 1-Day Observed Precipitation
Valid on: March 15, 2021 12:00 UTC

Fig. 6. 24-hour Estimated Observed Rainfall ending at 7am CDT 03/15/2021.

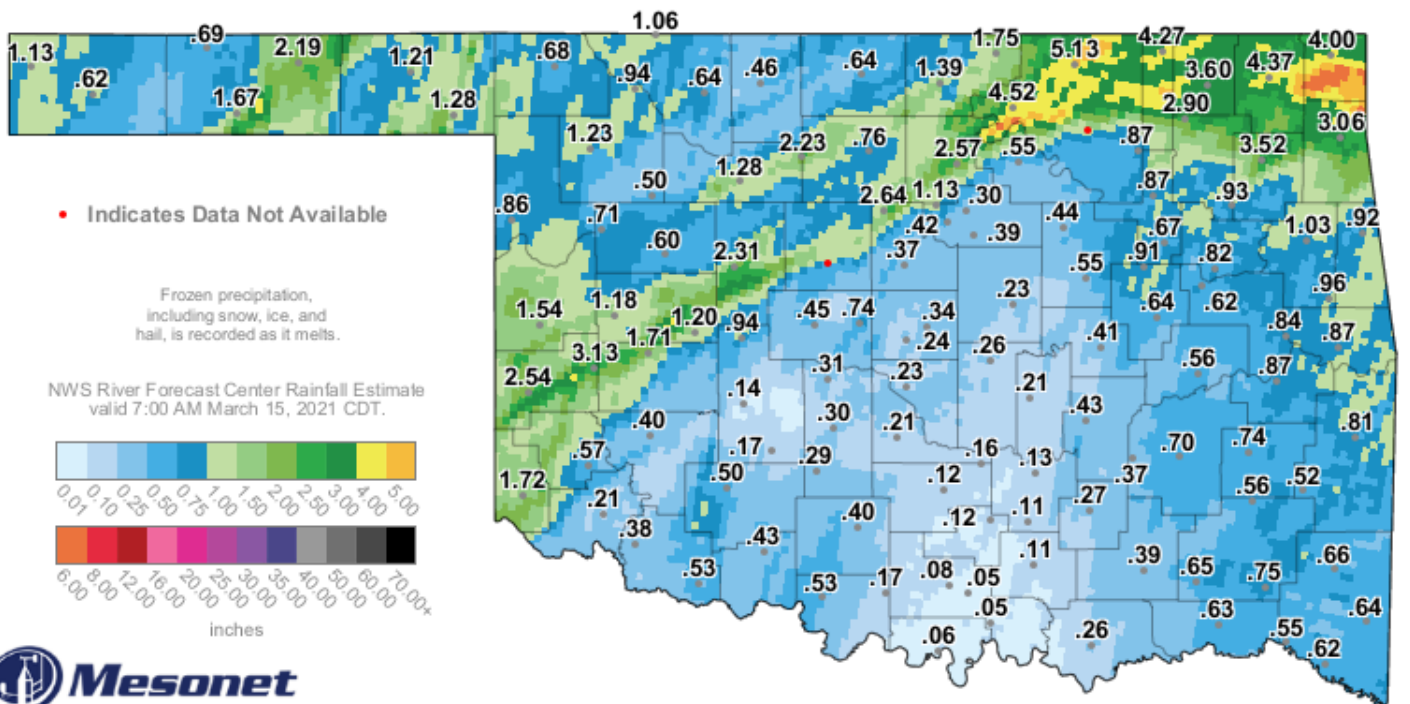


24-Hour Rainfall Accumulation (inches)

7:40 AM March 15, 2021 CDT

Created 7:46:12 AM March 15, 2021 CDT. © Copyright 2021

Fig. 7. OK Mesonet (values) and NWS RFC rainfall estimate (image) 24-hour rainfall ending at 7:40 am CDT 03/15/2021.

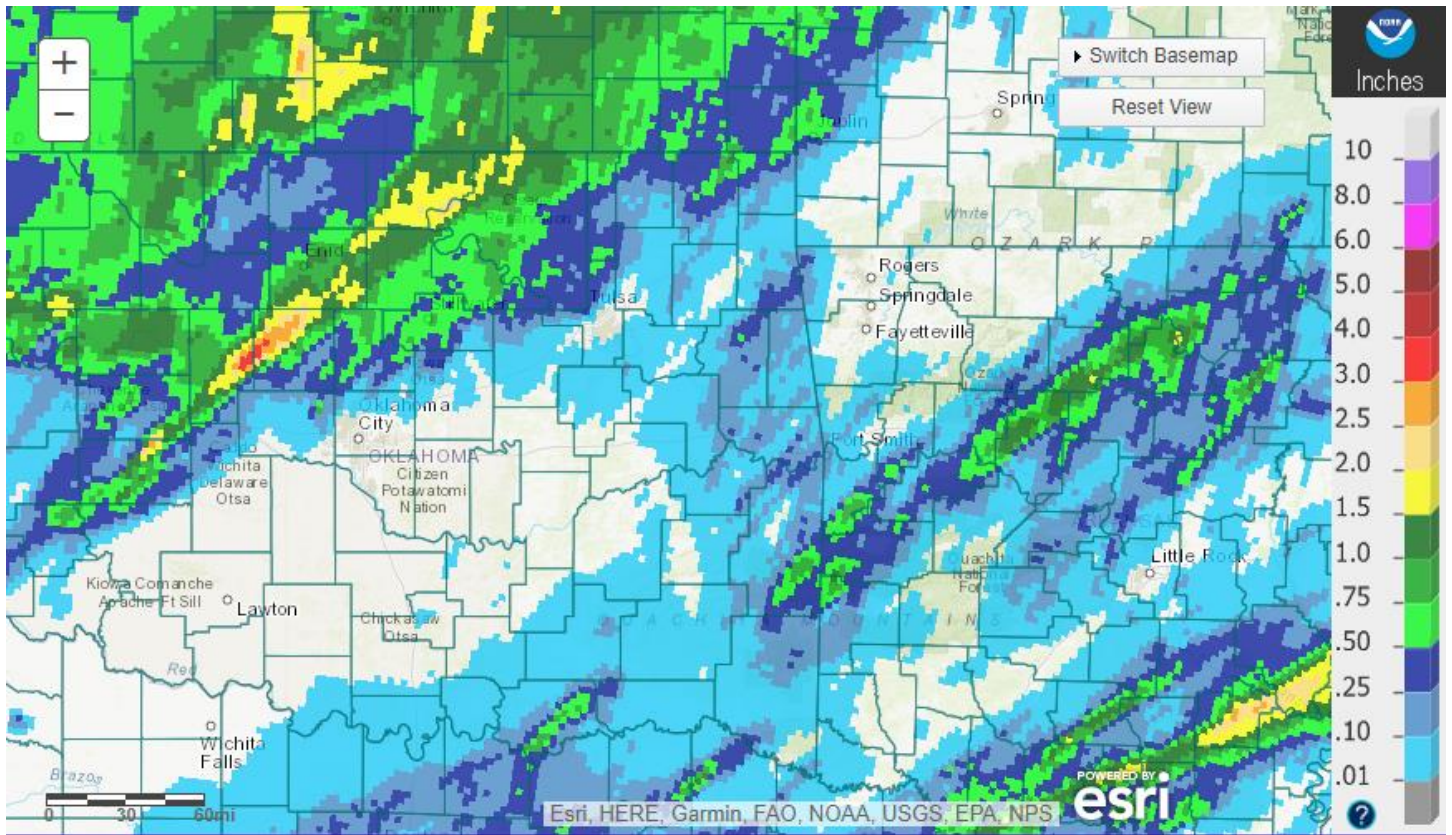


3-Day Rainfall Accumulation (inches)

7:55 AM March 15, 2021 CDT

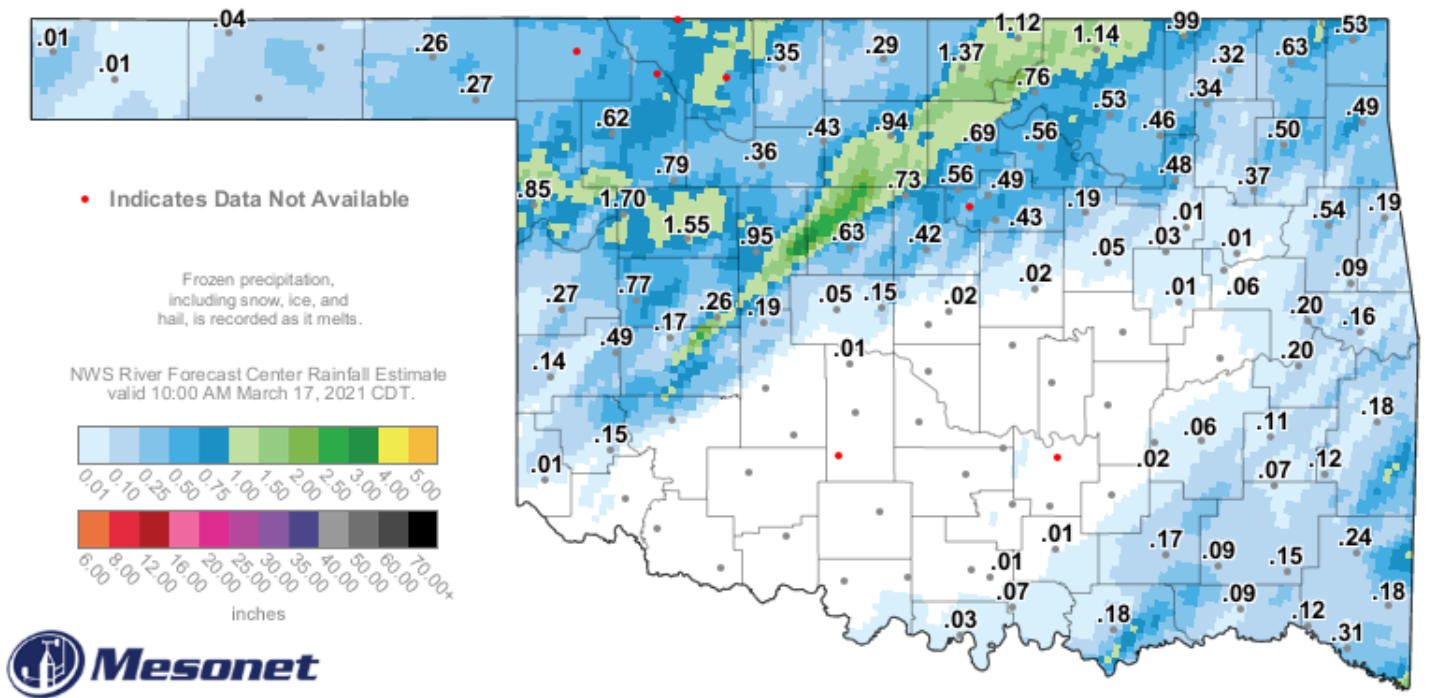
Created 8:00:54 AM March 15, 2021 CDT. © Copyright 2021

Fig. 8. OK Mesonet (values) and NWS RFC rainfall estimate (image) 3-day rainfall ending at 7:55 am CDT 03/15/2021.



Tulsa, OK: March 17, 2021 1-Day Observed Precipitation
Valid on: March 17, 2021 12:00 UTC

Fig. 9. 24-hour Estimated Observed Rainfall ending at 7am CDT 03/17/2021.

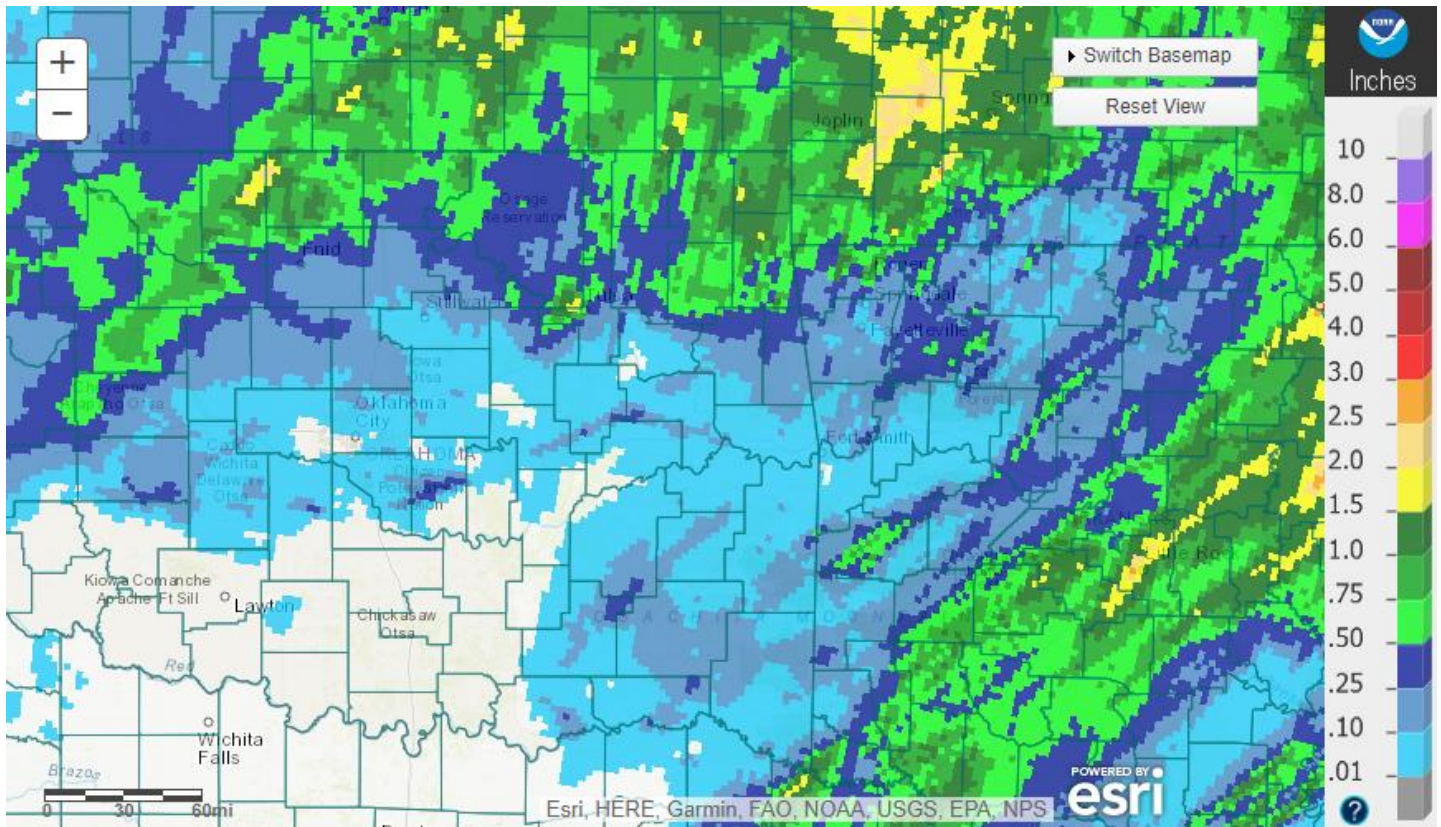


12-Hour Rainfall Accumulation (inches)

11:30 AM March 17, 2021 CDT

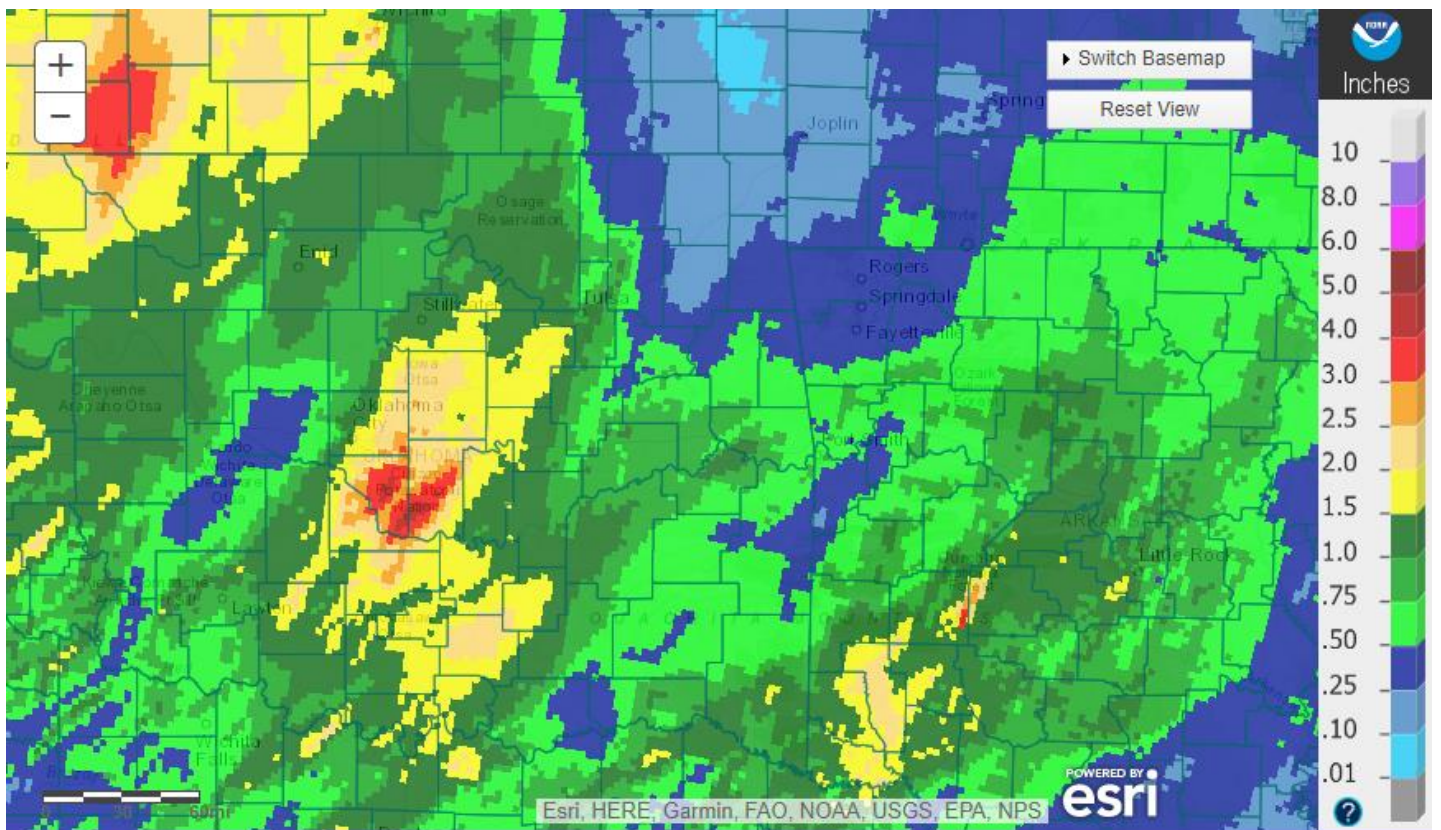
Created 11:35:54 AM March 17, 2021 CDT. © Copyright 2021

Fig. 10. OK Mesonet (values) and NWS RFC rainfall estimate (image) 24-hour rainfall ending at 11:30 am CDT 03/17/2021.



Tulsa, OK: March 18, 2021 1-Day Observed Precipitation
Valid on: March 18, 2021 12:00 UTC

Fig. 11. 24-hour Estimated Observed Rainfall ending at 7am CDT 03/18/2021.



Tulsa, OK: March 23, 2021 1-Day Observed Precipitation
Valid on: March 23, 2021 12:00 UTC

Fig. 12. 24-hour Estimated Observed Rainfall ending at 7am CDT 03/23/2021.

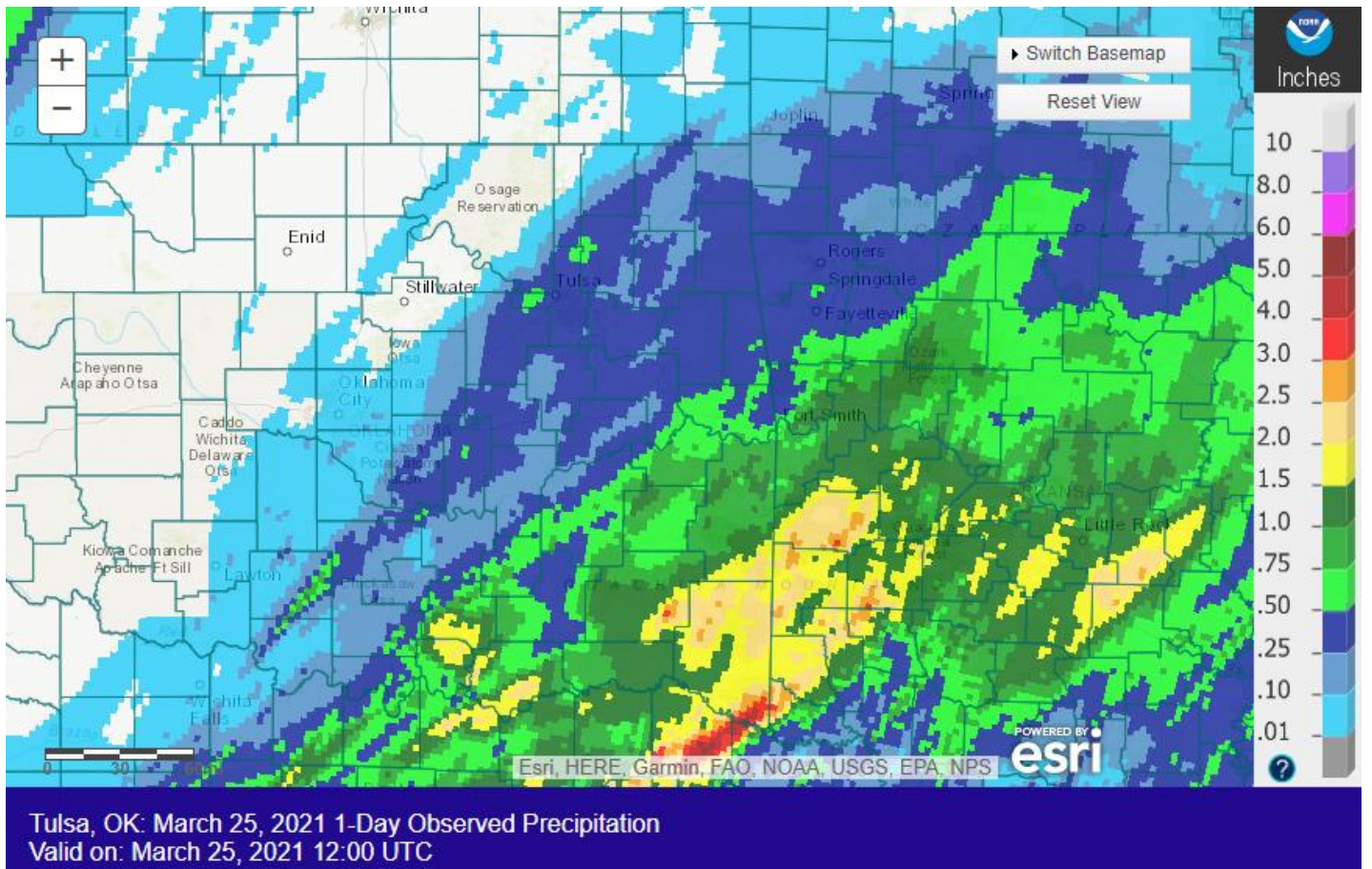


Fig. 13. 24-hour Estimated Observed Rainfall ending at 7am CDT 03/25/2021.

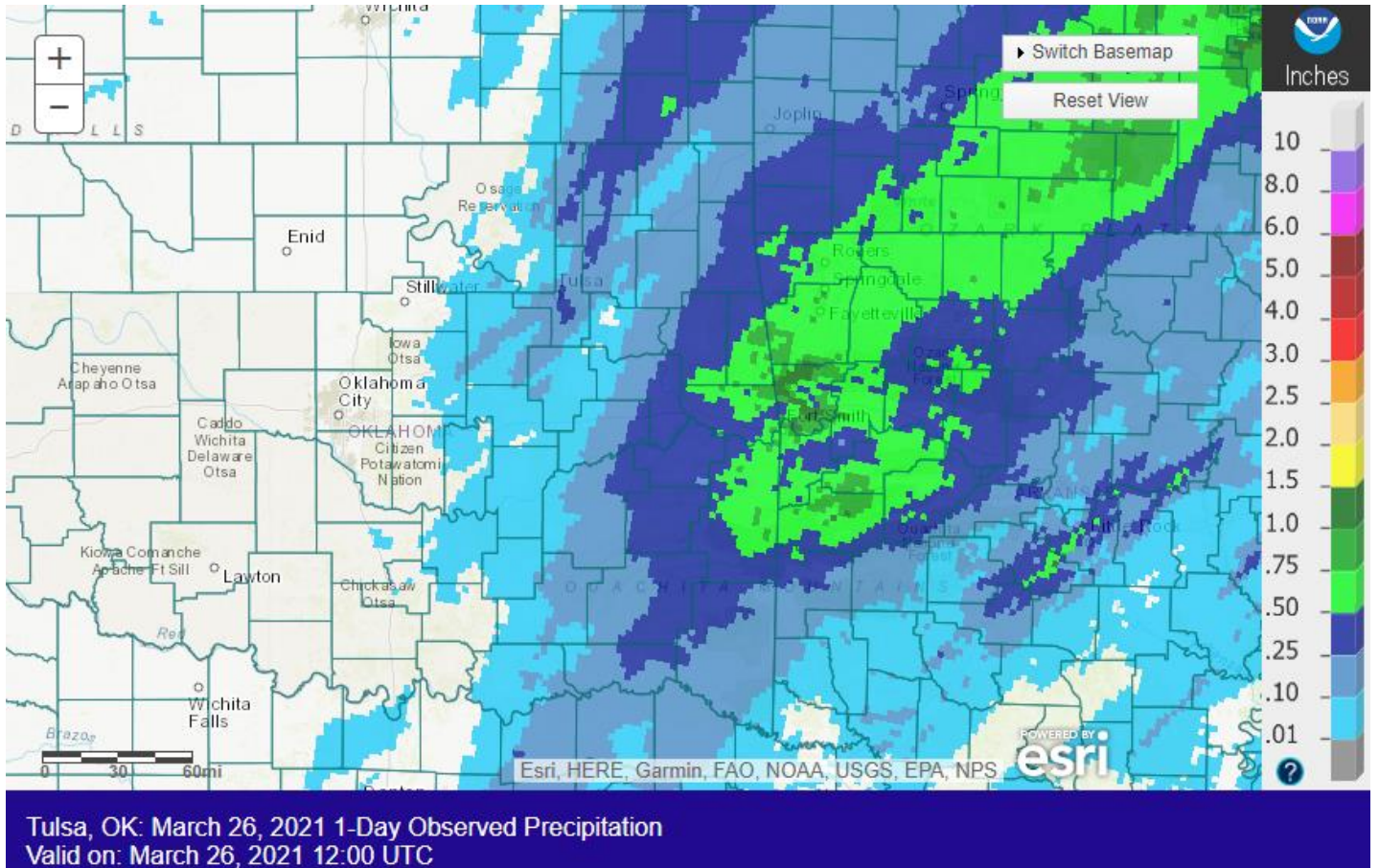


Fig. 14. 24-hour Estimated Observed Rainfall ending at 7am CDT 03/26/2021.

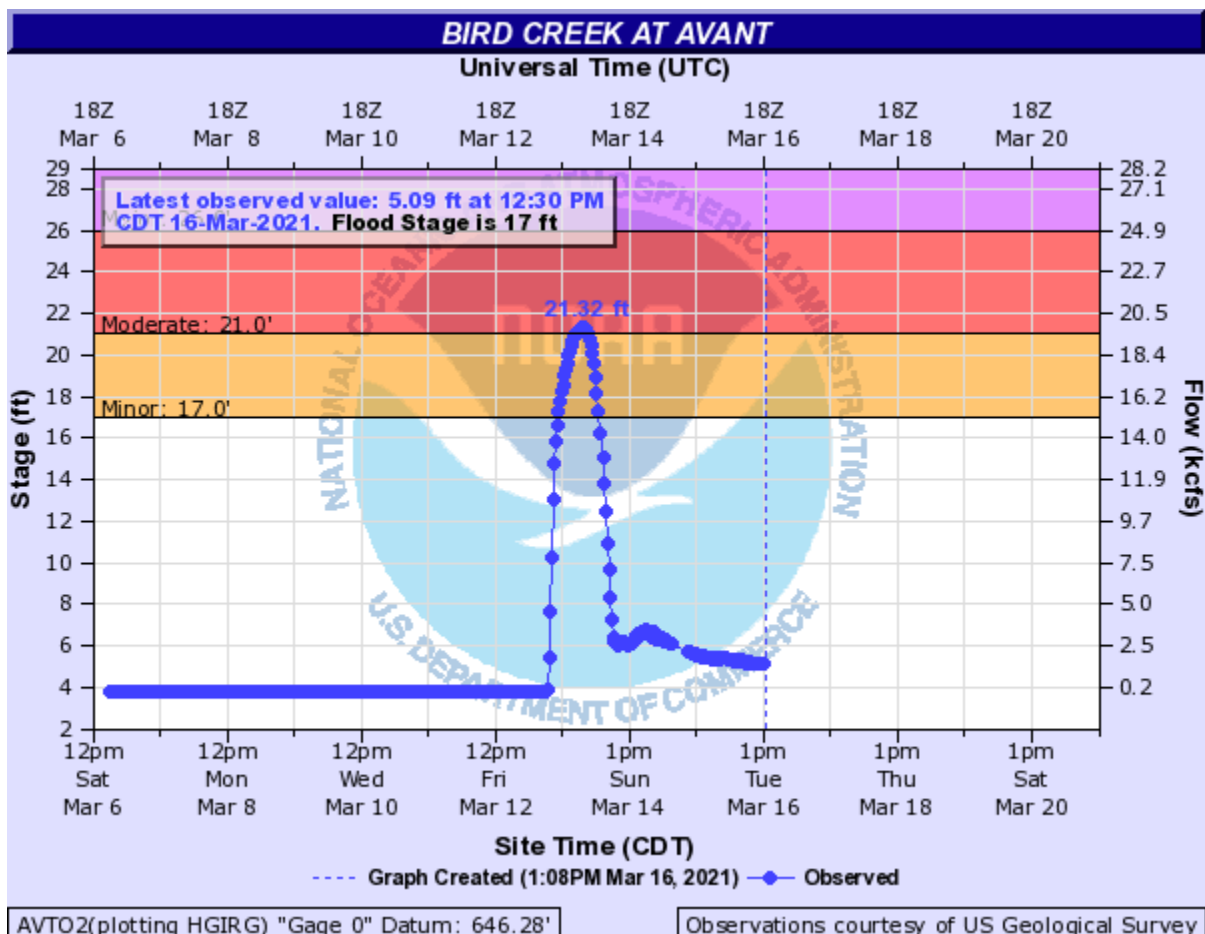
Written by:
 Nicole McGavock
 Service Hydrologist
 WFO Tulsa

Products issued in March 2021:

- *CWYO2 became a daily river forecast point September 7, 2016
- *MLBA4 and OZGA4 transferred to NWS Tulsa HSA February 5, 2014
- *Mixed case River Flood products began July 31, 2013

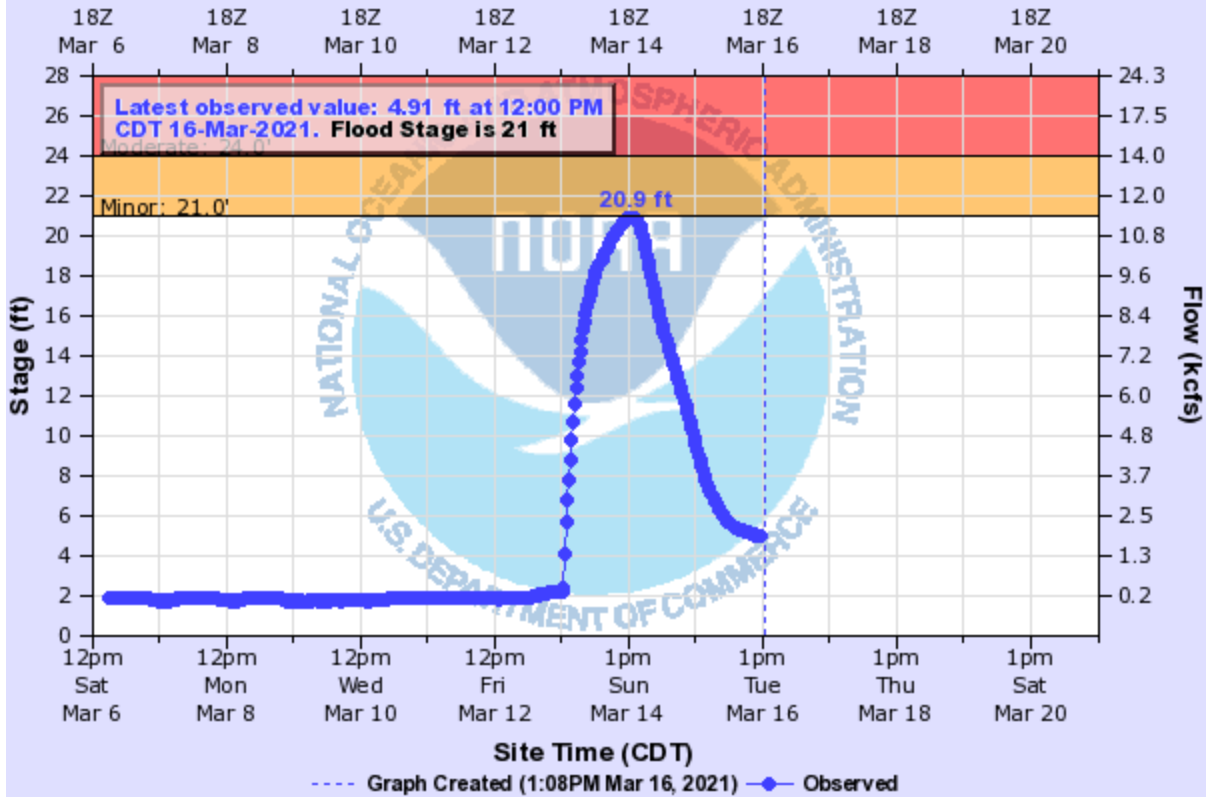
- 1 Flash Flood Warnings (FFW)
- 1 Flash Flood Statements (FFS)
- 1 Flash/Areal Flood Watches (FFA) (3 Watch FFA CON/EXT/EXA/EXB/CAN)
- 6 Urban and Small Stream Advisories (FLS)
- 0 Areal Flood Warnings (FLW)
- 0 Areal Flood Statements (FLS)
- 10 River Flood Warnings (FLW) (includes category increases)
- 59 River Flood Statements (FLS)
- 5 River Flood Advisories (FLS) (24 Advisory FLS CON/EXT/CAN)
- 0 River Flood Watches (FFA) (0 Watch FFA CON/EXT/CAN)
- 0 River Statements (RVS)
- 0 Hydrologic Outlooks (ESF)
- 0 Drought Information Statements (DGT)

Preliminary Hydrographs:



BIRD CREEK NEAR SPERRY

Universal Time (UTC)

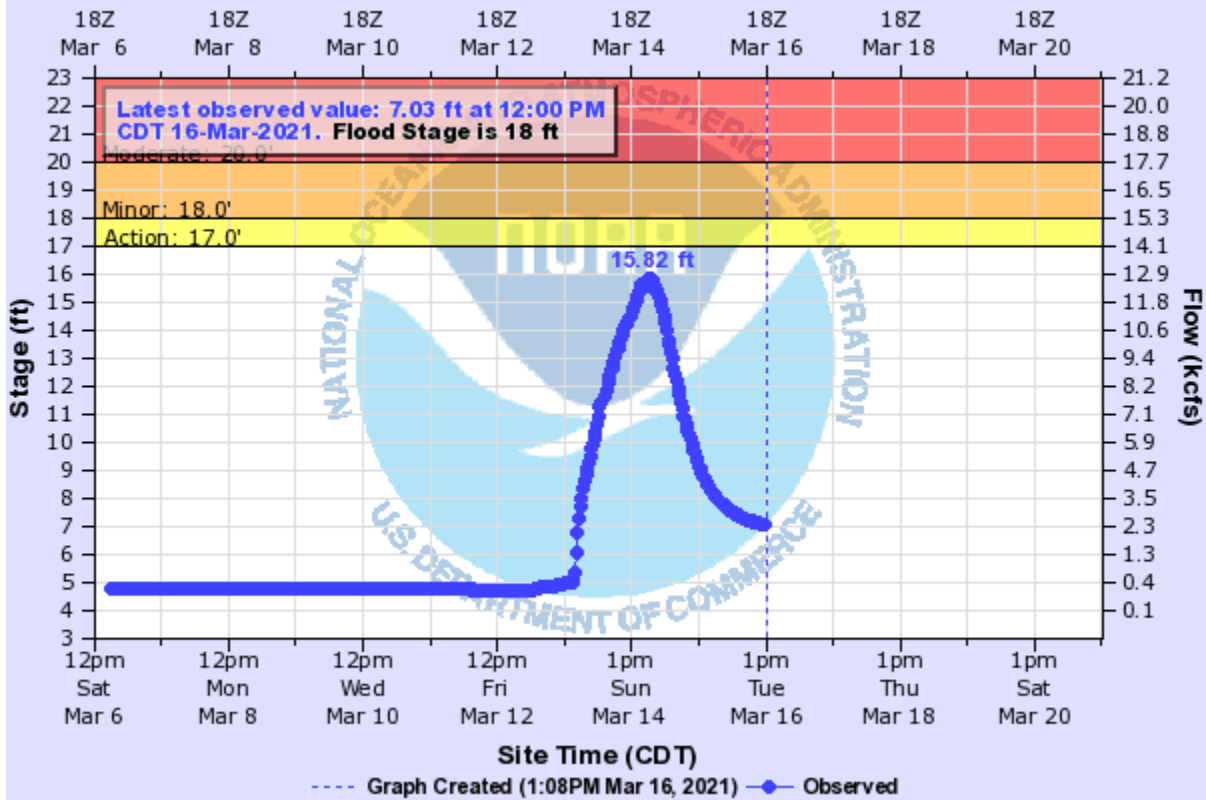


SPEO2(plotting HGIRG) "Gage 0" Datum: 579.43'

Observations courtesy of US Geological Survey

BIRD CREEK NEAR OWASSO

Universal Time (UTC)

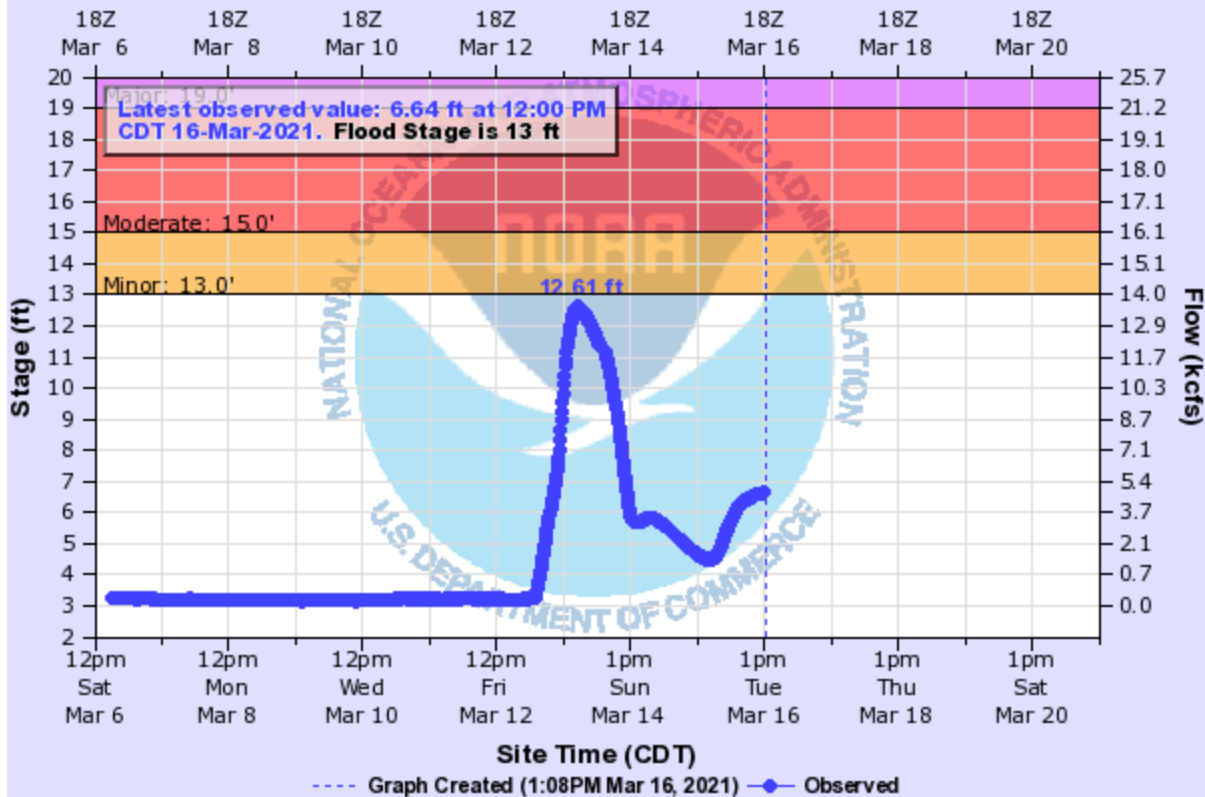


OWSO2(plotting HGIRG) "Gage 0" Datum: 560.17'

Observations courtesy of US Geological Survey

CANEY RIVER AT BARTLESVILLE

Universal Time (UTC)

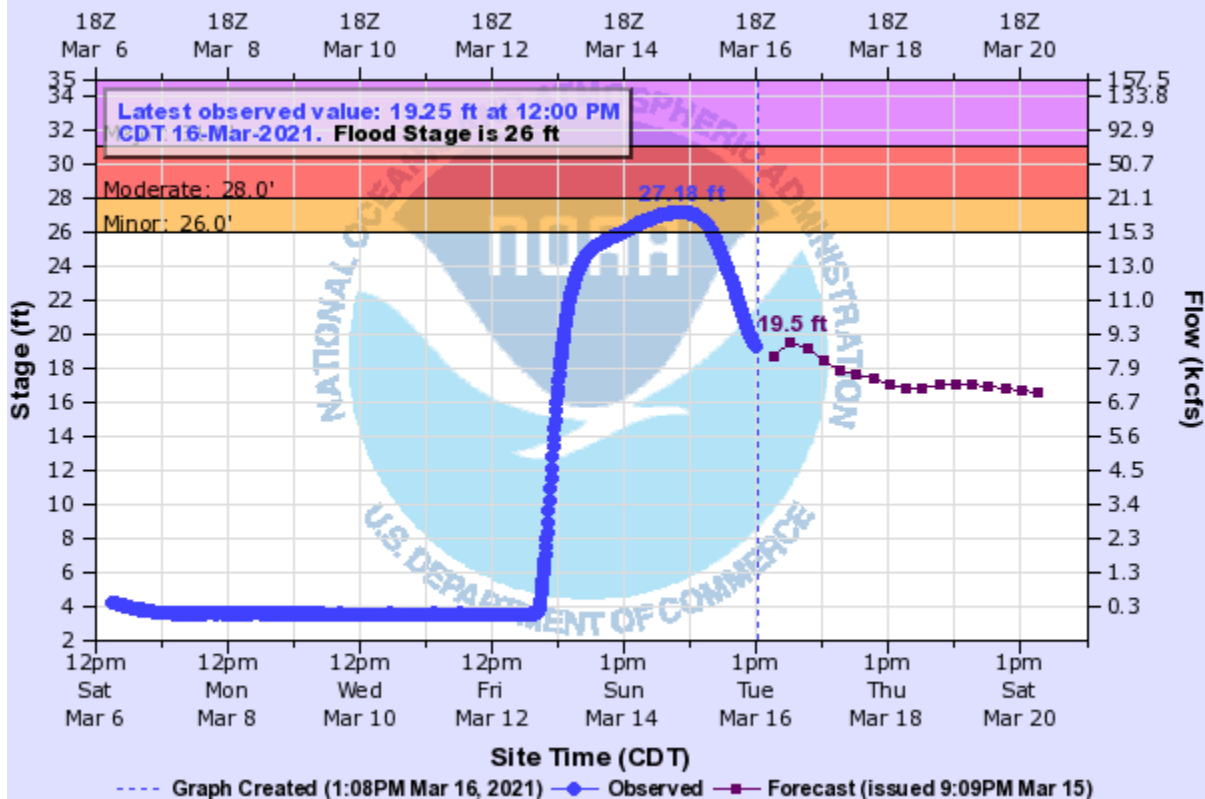


BVLO2(plotting HGIRG) "Gage 0" Datum: 653.33'

Observations courtesy of US Geological Survey

CANEY RIVER NEAR RAMONA

Universal Time (UTC)

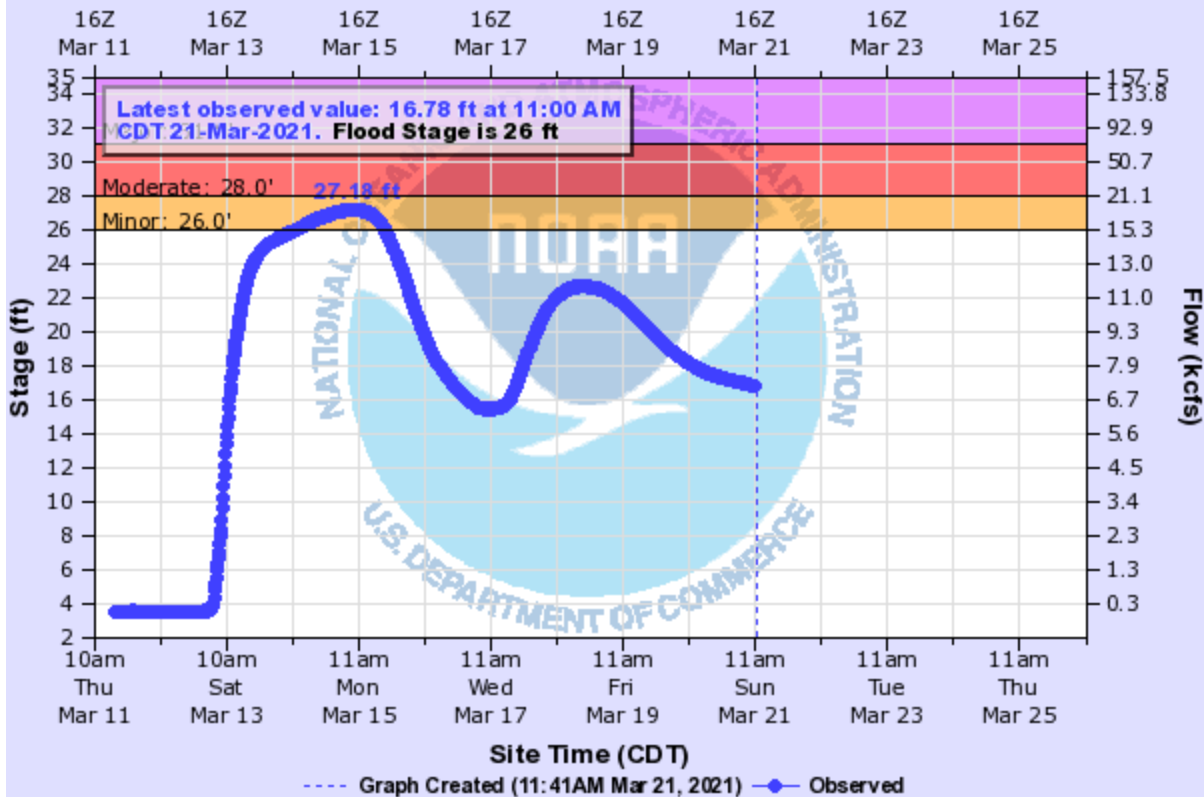


RAMO2(plotting HGIRG) "Gage 0" Datum: 586.43'

Observations courtesy of US Geological Survey

CANEY RIVER NEAR RAMONA

Universal Time (UTC)

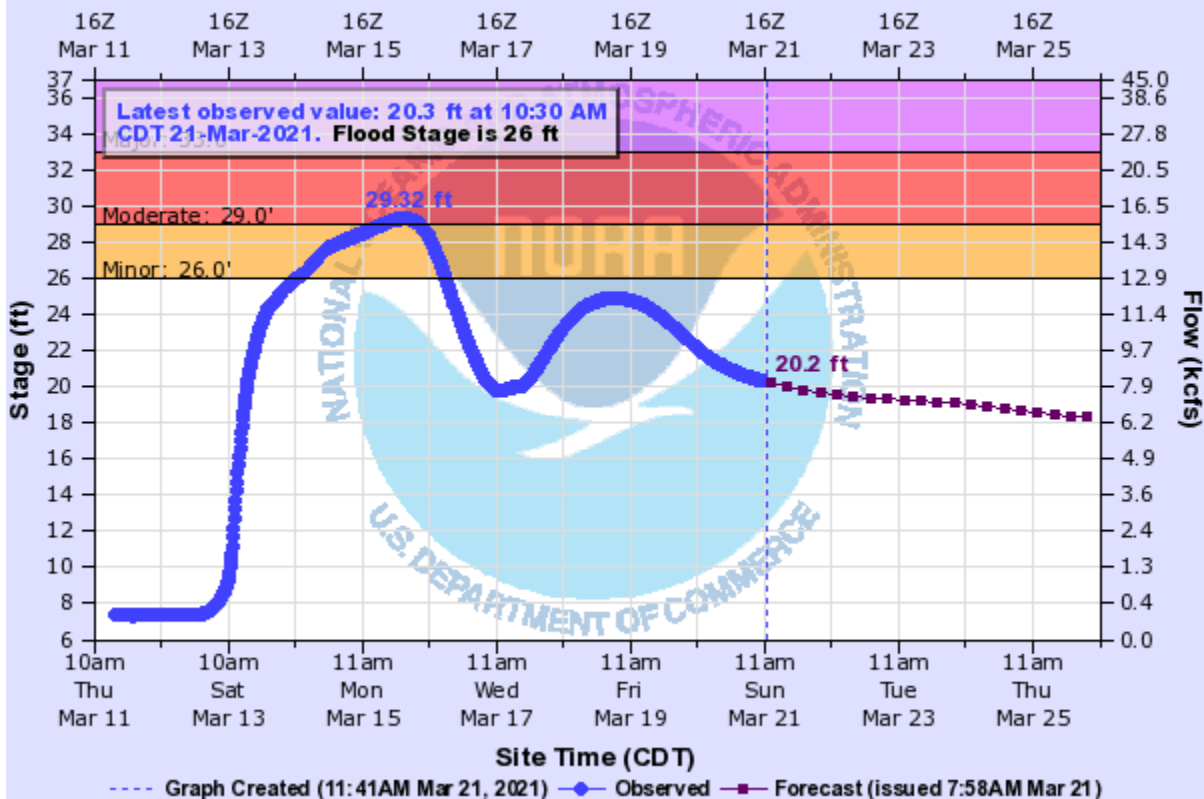


RAMO2(plotting HGIRG) "Gage 0" Datum: 586.43'

Observations courtesy of US Geological Survey

CANEY RIVER NEAR COLLINSVILLE

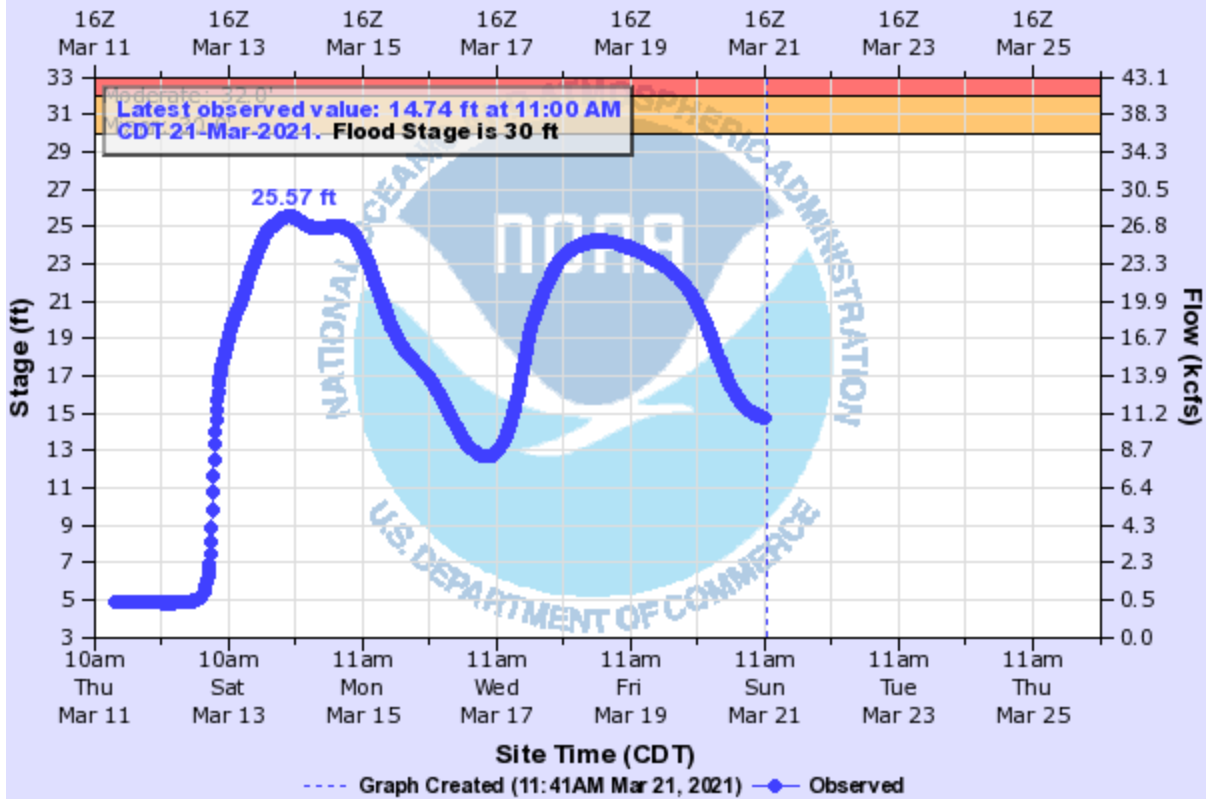
Universal Time (UTC)



CVLO2(plotting HGIRG) "Gage 0" Datum: 565.72'

VERDIGRIS RIVER NEAR LENAPAH

Universal Time (UTC)

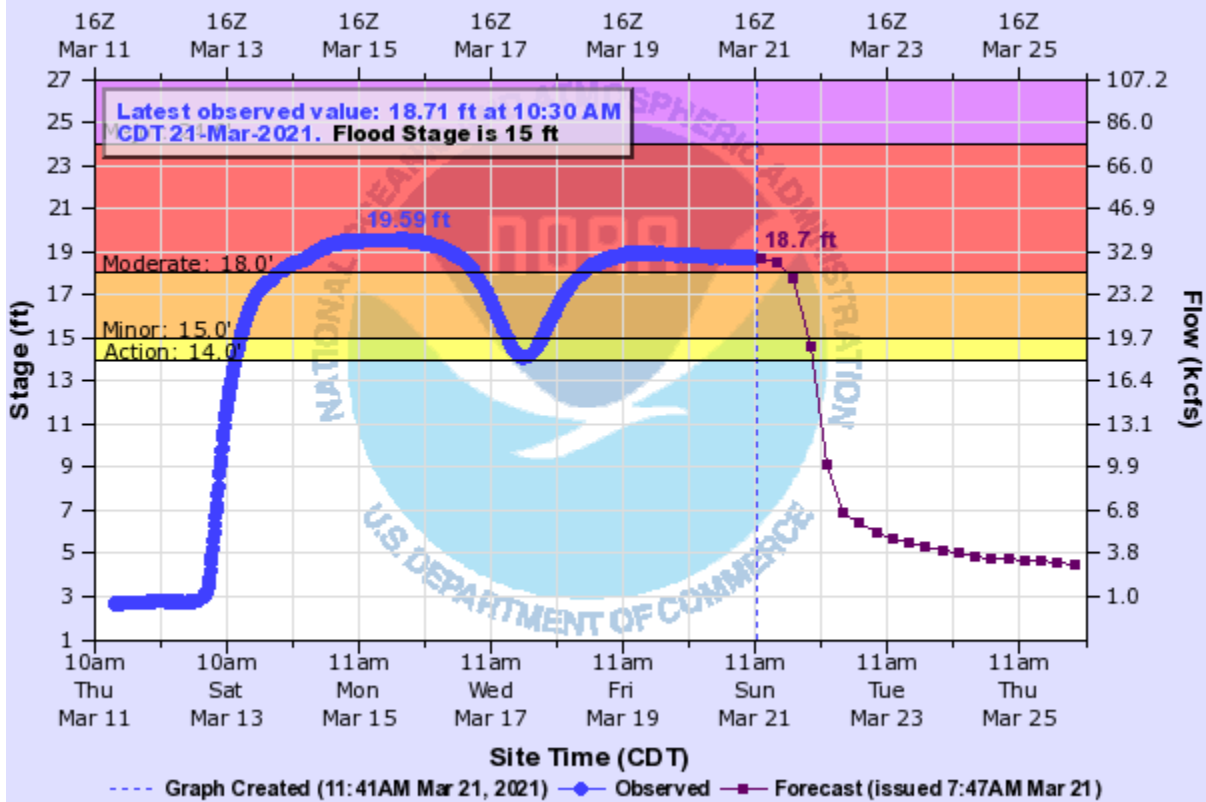


LEPO2(plotting HGIRG) "Gage 0" Datum: 644.9'

Observations courtesy of US Geological Survey

NEOSHO RIVER NEAR COMMERCE

Universal Time (UTC)

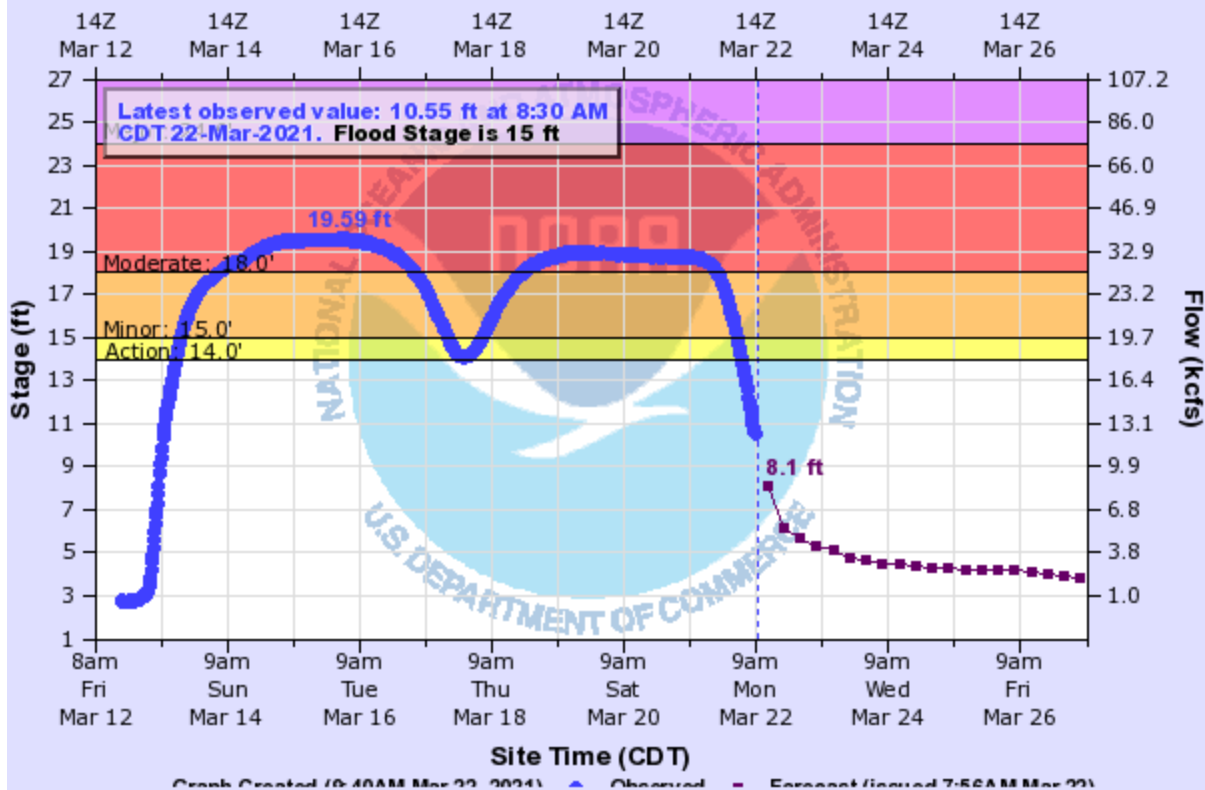


COMO2(plotting HGIRG) "Gage 0" Datum: 748.97'

Observations courtesy of US Geological Survey

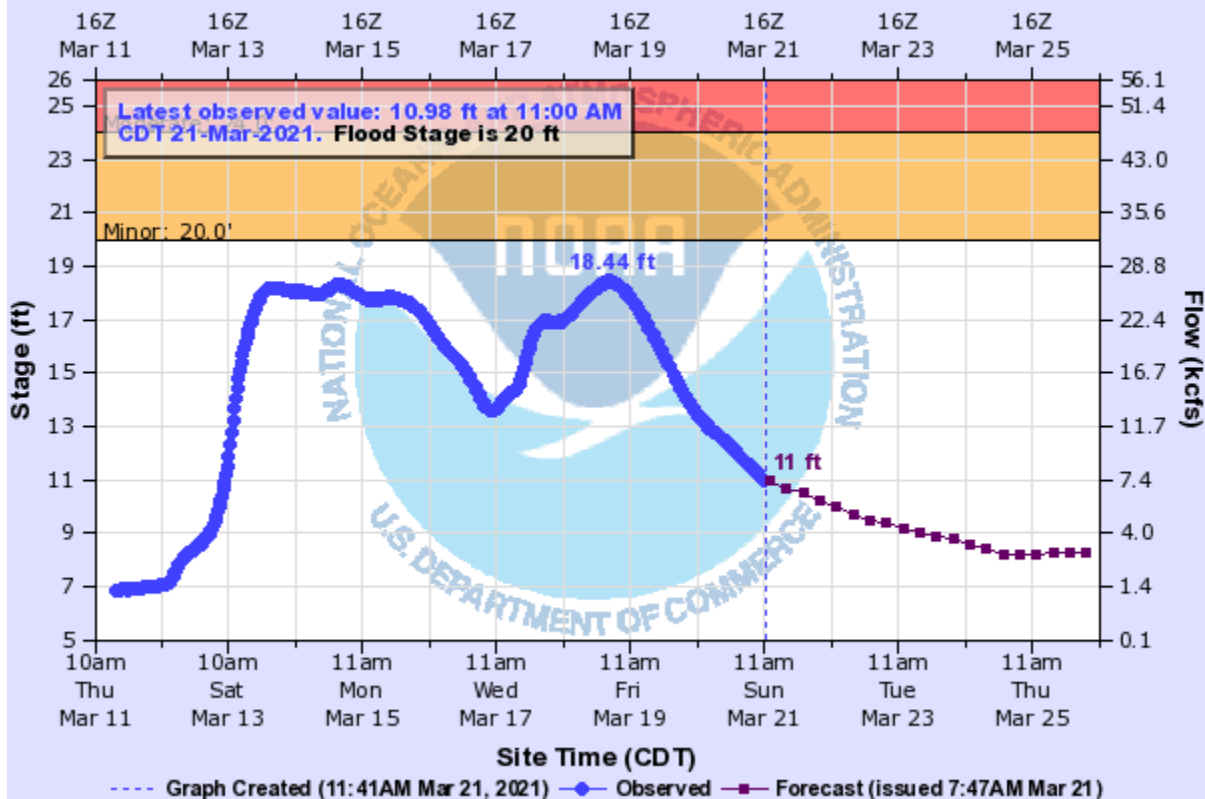
NEOSHO RIVER NEAR COMMERCE

Universal Time (UTC)



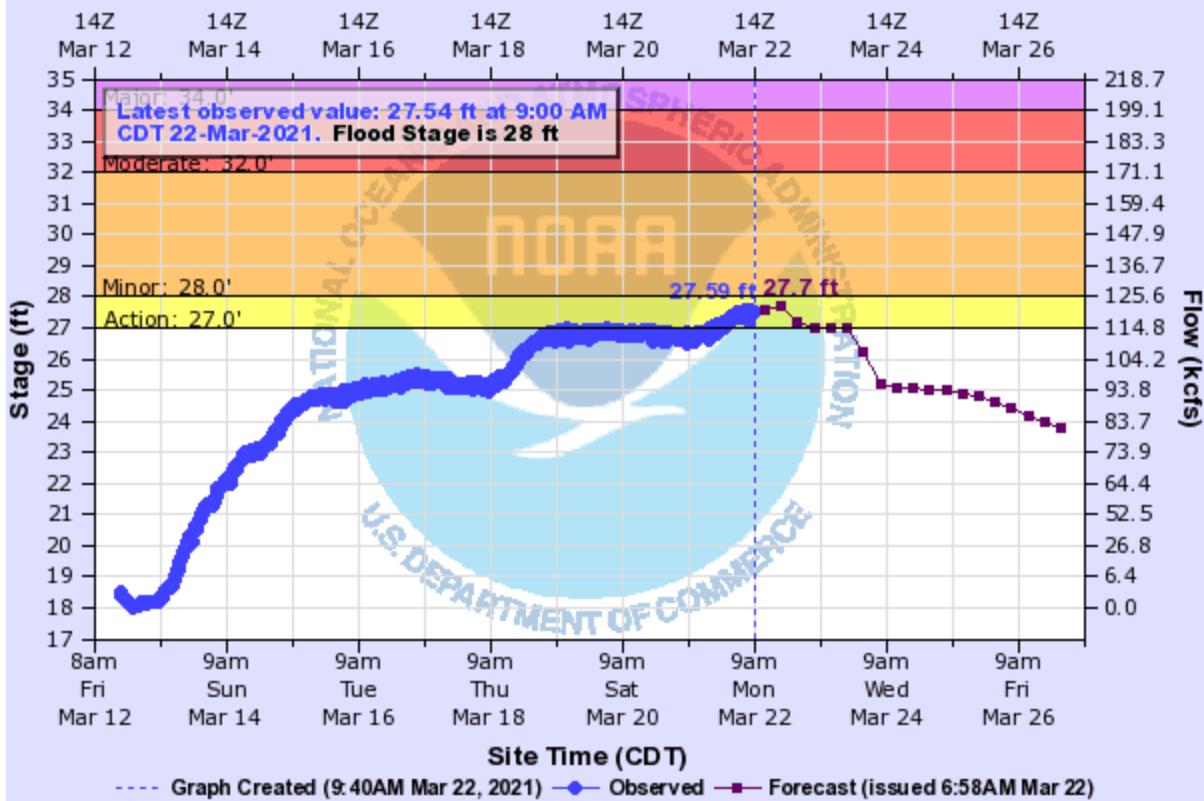
SPRING RIVER NEAR QUAPAW

Universal Time (UTC)



ARKANSAS RIVER NEAR MUSKOGEE

Universal Time (UTC)

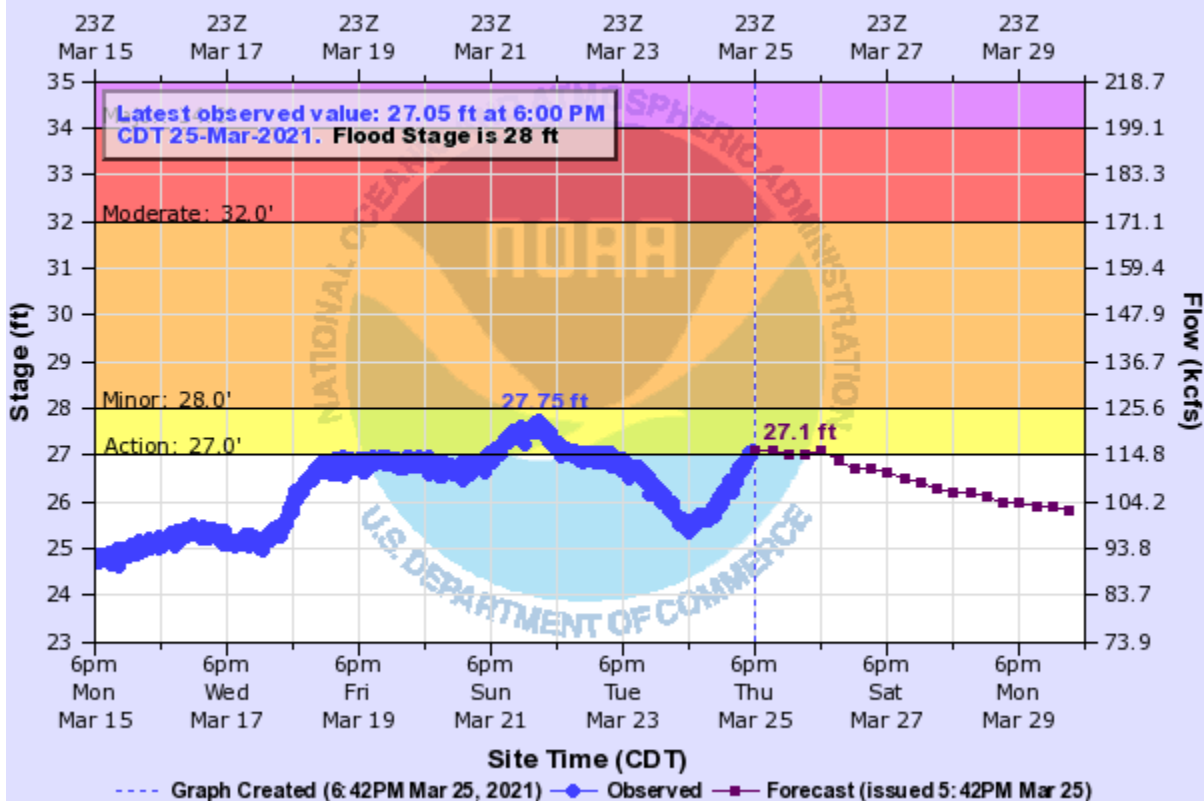


MKGO2(plotting HGIRG) "Gage 0" Datum: 471.38'

Observations courtesy of US Geological Survey

ARKANSAS RIVER NEAR MUSKOGEE

Universal Time (UTC)

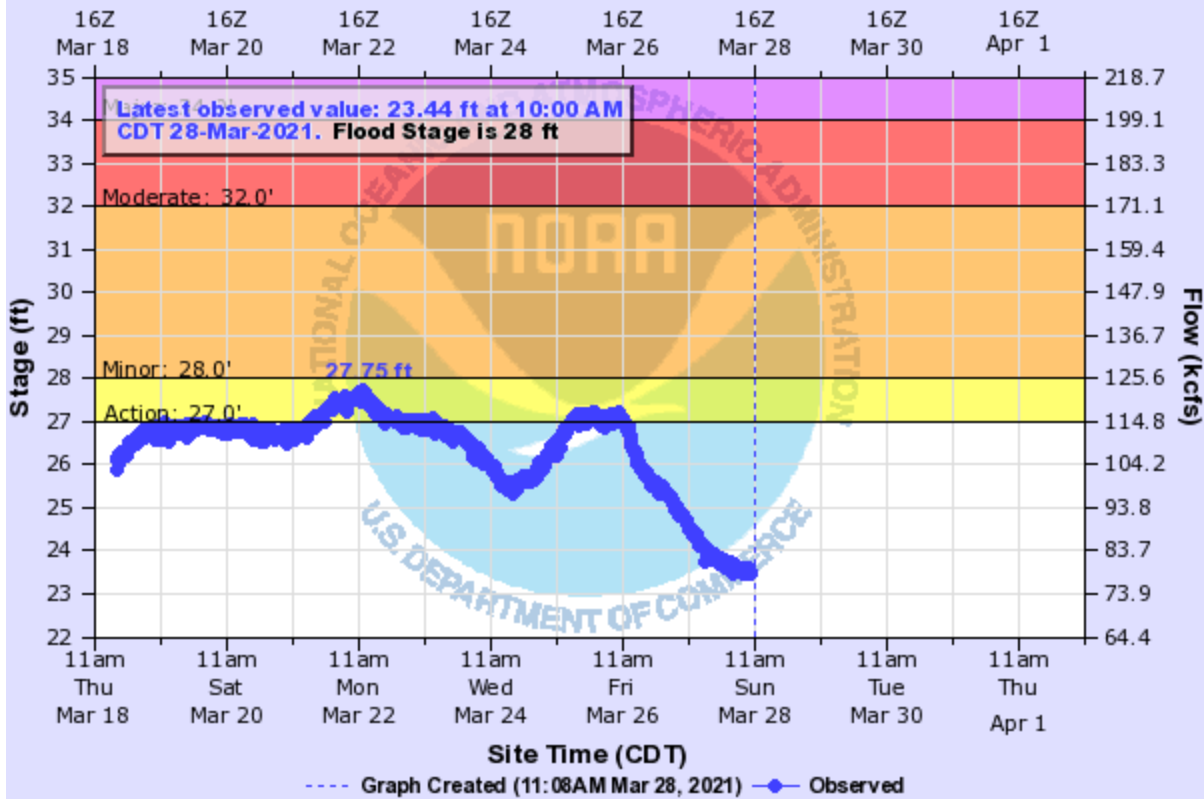


MKGO2(plotting HGIRG) "Gage 0" Datum: 471.38'

Observations courtesy of US Geological Survey

ARKANSAS RIVER NEAR MUSKOGEE

Universal Time (UTC)

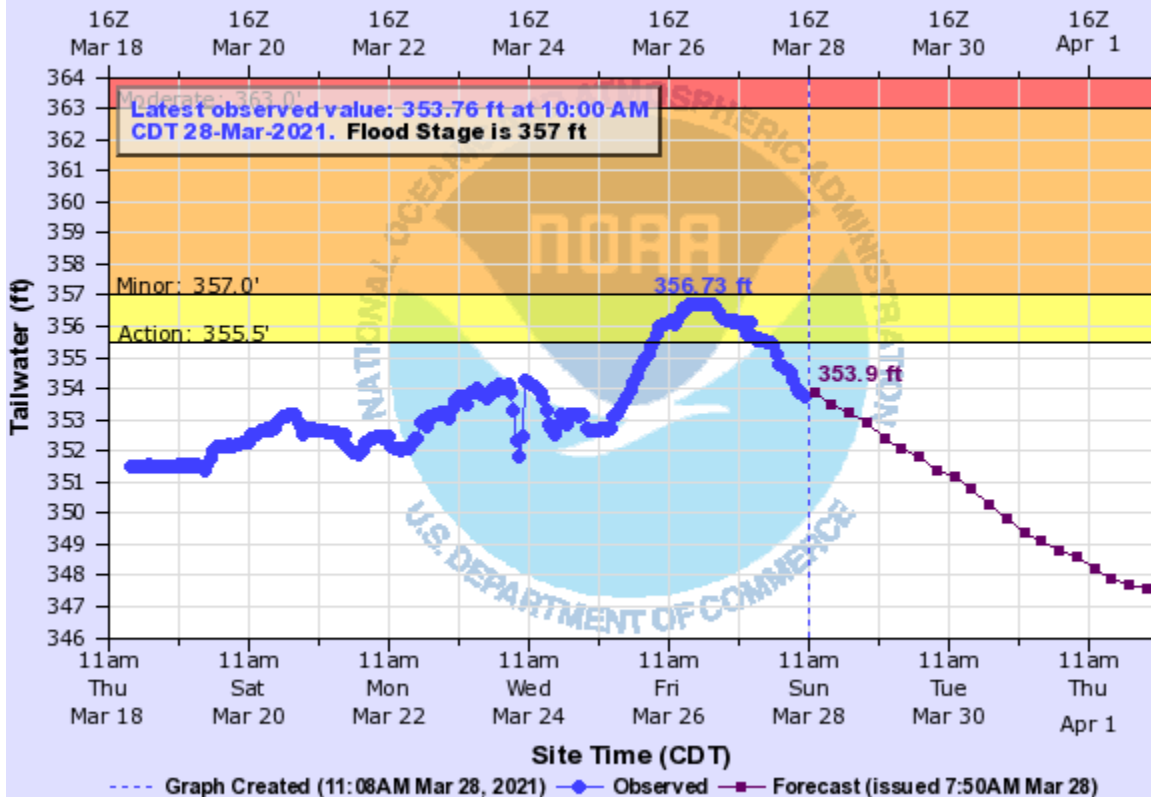


MKGO2(plotting HGIRG) "Gage 0" Datum: 471.38'

Observations courtesy of US Geological Survey

ARKANSAS RIVER AT OZARK L/D TAILWATER

Universal Time (UTC)

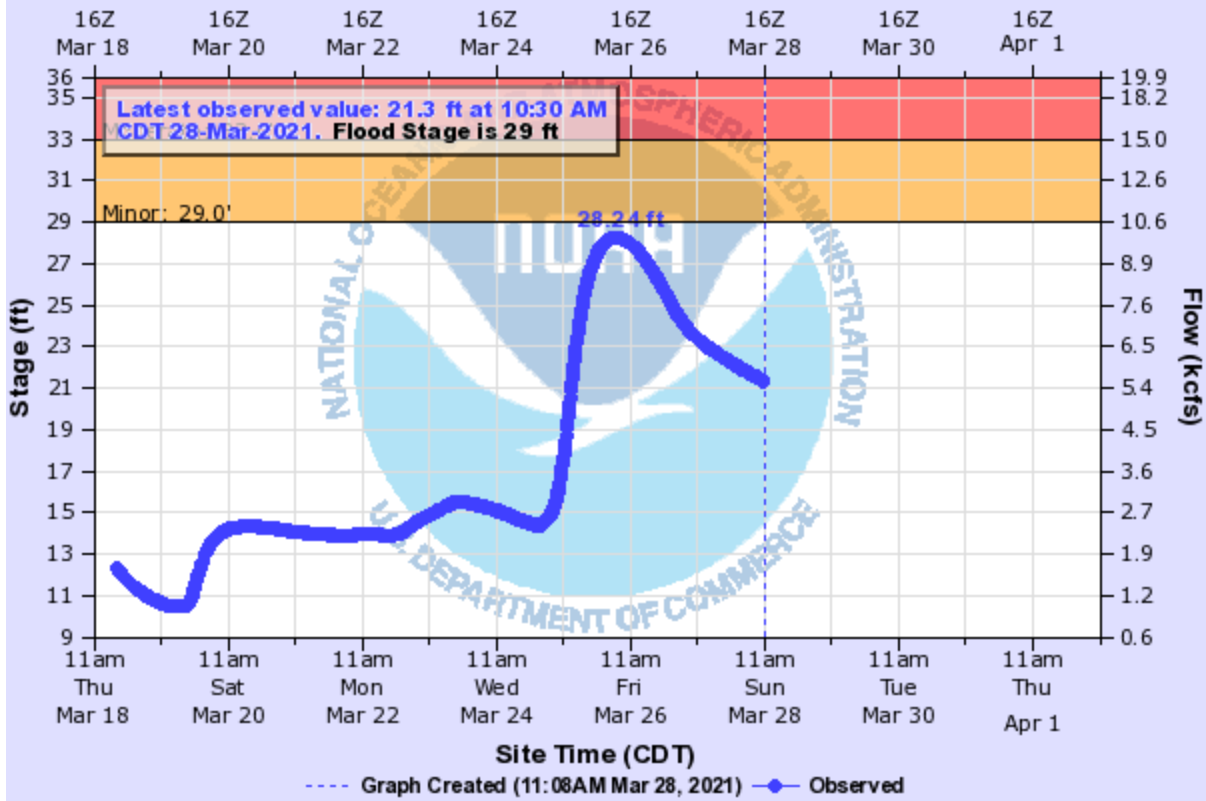


OZGA4(plotting HTIRG) "Gage 0" Datum: 0'

Observations courtesy of US Army Corps of Engineers - LRD

POTEAU RIVER NEAR PANAMA

Universal Time (UTC)



PANO2(plotting HGIRG) "Gage 0" Datum: 387.96'

Observations courtesy of US Geological Survey