



# **2017 PRECIPITATION IN THE EDWARDS AQUIFER REGION**



**November 2018**

The Edwards Aquifer Authority (EAA) monitors precipitation throughout the region using a network of 74 real-time rain gauges. Rainfall data is used as input for watershed computer models that can provide estimates of monthly recharge to the aquifer. Collected over several years or decades, the extensive database of rainfall information can also be useful for monitoring climate trends, evaluating relationships between rainfall and aquifer levels, or for understanding how global-scale phenomena such as “El Nino” (which refers to above-average sea surface temperatures in the equatorial region of the Pacific Ocean) may affect rainfall in Central Texas.

The locations of the EAA rain gauges are shown in Figure 1. In general, rain gauges are not always reliable indicators of total rainfall over a region. Rainfall can vary greatly over relatively short distances and a gauge only reflects rainfall at a specific point. Additionally, gauges are susceptible to occasional malfunctions such as clogging, battery or electronic failure, or physical damage. NEXRAD (Next-Generation Radar) data from the National Weather Service (NWS) provides a potential solution to the limitations of individual rain gauges because it provides continuous coverage of the entire region based on overlapping coverage from NEXRAD Doppler radar stations in Brackettville, Corpus Christi, New Braunfels, and Granger, Texas. However, NEXRAD measures reflectivity of precipitation near ground level and not the actual amount of precipitation as measured by rain gauges. For this reason, EAA takes a two-step approach by performing a quality review of the rain gauge data each month and using the operational rain-gauge data as a “ground-truth” to calibrate the NWS NEXRAD data. The resulting product is a dataset of hourly rainfall totals for a grid of 4 km × 4 km pixels over the entire region of interest that extends back to January 1, 2003.

Figure 2 shows the calibrated NEXRAD coverage area with a color map indicating total 2017 rainfall for each 16-km<sup>2</sup> pixel. The high degree of spatial variability in rainfall totals can be seen, with the highest rainfall total of 47.2 inches in Travis county at the northeast edge of the coverage area and the lowest total of 16.4 inches in Schleicher County at the far northwestern corner of the coverage area. This pattern of highest rainfall totals to the east and lowest totals to the west is typical of most years in the South-Central Texas region. The average recharge over the entire coverage area was 24.6 inches.

Figure 2 also shows delineations of the nine watershed catchment areas that contain streams that cross the Edwards Aquifer recharge zone. The rainfall over these watersheds is of interest because their catchment areas convey water to the Edwards Aquifer recharge zone and the data can be used as input to the EAA’s HSPF (Hydrologic Simulation Program—Fortran) models to estimate recharge. Table 1 provides the 2017 area-averaged rainfall totals for the nine watersheds obtained from the calibrated NEXRAD data.

Because the timeframe covered by EAA’s calibrated NEXRAD rainfall data does not begin until year 2003, it is not yet suited for evaluating long term historical trends in annual rainfall. For this type of analysis, we rely on data at individual rain gauges that have been in place for many decades. Table 2 shows how the 2017 annual rainfall for several selected gauges across the region compares to the long-term average rainfall. Rainfall varied from above average to below average at these locations with no particular spatial trend. Generally, the calibrated NEXRAD rainfall totals should be considered the best available representation of the annual rainfall total. Table 3 lists the annual rainfall totals for several gauge locations going

back to 1934. These records indicate how variable rainfall can be at any location from year to year. For example, the lowest annual rainfall total observed at San Antonio Airport rain gauge was 13.7 inches in 1954, while the highest was 52.3 inches in 1973. Although these records show extended periods of above-average or below-average rainfall, there does not appear to be any significant trend of increasing or decreasing annual rainfall totals in the region over the long term.

The long-term records for these rain gauges and many other weather stations throughout the region can be obtained online from the National Centers for Environmental Information (formerly the National Climatic Data Center) at <http://www.ncdc.noaa.gov/cdo-web/search>. Data from the EAA's rain gauge network or calibrated NEXRAD database may be obtained from EAA upon request.

**TABLE 1. 2017 RAINFALL TOTALS FOR NINE DELINEATED CONTRIBUTING ZONE WATERSHEDS.**

| Gauge                                        | 2017 Area Average Rainfall (inches) |
|----------------------------------------------|-------------------------------------|
| Nueces-West Nueces River Basins              | 22.0                                |
| Frio-Dry Frio River Basins                   | 24.3                                |
| Sabinal River Basin                          | 22.2                                |
| Area Between Sabinal and Medina River Basins | 22.7                                |
| Medina River Basin                           | 24.0                                |
| Area Between Medina and Cibolo River Basins  | 25.2                                |
| Cibolo and Dry Comal Creek Basins            | 26.1                                |
| Guadalupe River Basin                        | 24.3                                |
| Blanco River Basin                           | 30.9                                |

**TABLE 2. DEVIATION FROM MEAN RAINFALL VALUES, 2017. RAINFALL AMOUNTS ARE IN INCHES**

| Station Name              | County  | Long-Term Average | 2017 Total | Deviation from Average |
|---------------------------|---------|-------------------|------------|------------------------|
| San Antonio Intl. Airport | Bexar   | 30.61             | 27.33      | -3.28                  |
| San Marcos                | Hays    | 34.36             | 42.56      | 7.24                   |
| Hondo                     | Medina  | 28.62             | 24.32      | -4.40                  |
| Sabinal                   | Uvalde  | 24.16             | 27.14      | 2.24                   |
| Boerne                    | Kendall | 34.14             | 28.84      | -5.30                  |
| Brackettville 22N         | Kinney  | 22.20             | 20.03      | -1.46                  |

**TABLE 3. ANNUAL PRECIPITATION FOR SELECTED PRECIPITATION STATIONS IN THE EDWARDS AQUIFER REGION, 1934–2017 (IN INCHES).**

| Year | Brackettville<br>22N | Uvalde | Sabinal            | Hondo              | San Antonio<br>Intl. Airt. | Boerne | New<br>Braunfels   | San Marcos         |
|------|----------------------|--------|--------------------|--------------------|----------------------------|--------|--------------------|--------------------|
| 1934 | ---                  | 16.70  | 18.07              | 23.97              | 27.65                      | 26.78  | 30.80              | 35.67              |
| 1935 | ---                  | 41.17  | 48.21              | 58.73              | 42.93                      | 52.93  | 41.67              | 41.09              |
| 1936 | 22.34                | 24.53  | 26.53              | 35.27              | 34.11                      | 47.59  | 30.41              | 33.48              |
| 1937 | 16.85                | 17.88  | 9.57 <sup>a</sup>  | 22.93              | 26.07                      | 32.81  | 29.19              | 26.03 <sup>a</sup> |
| 1938 | 19.97                | 13.12  | 15.39              | 27.56              | 23.26                      | 24.14  | 28.32              | 28.17              |
| 1939 | 18.38                | 25.30  | 13.98 <sup>b</sup> | 23.14              | 18.83                      | 26.20  | 13.35              | 18.59              |
| 1940 | 22.43                | 27.66  | 27.51              | 28.13              | 30.79                      | 32.29  | 38.11              | 43.57              |
| 1941 | 21.52                | 31.79  | 33.74 <sup>a</sup> | 44.07              | 26.34                      | 41.60  | 42.99              | 48.41              |
| 1942 | 21.01                | 19.01  | 11.37 <sup>a</sup> | 34.83              | 38.46                      | 31.12  | 42.08              | 44.65              |
| 1943 | 23.39 <sup>b</sup>   | 20.63  | 17.21              | 31.43              | 20.51                      | 26.33  | 29.93              | 25.45              |
| 1944 | 24.76                | 32.76  | 27.62 <sup>a</sup> | 32.46              | 33.19                      | 42.98  | 43.14              | 47.42              |
| 1945 | 15.69                | 22.37  | 26.60              | 29.57              | 30.46                      | 33.50  | 39.38              | 31.74 <sup>b</sup> |
| 1946 | 19.10                | 26.41  | 14.16 <sup>a</sup> | 29.65              | 45.17                      | 45.62  | 61.60              | 52.24              |
| 1947 | 22.92 <sup>b</sup>   | 22.67  | ---                | 18.98              | 17.32                      | 21.89  | 27.52              | 27.53              |
| 1948 | 20.02 <sup>a</sup>   | 18.31  | ---                | 28.82              | 23.64                      | 23.77  | 19.88 <sup>b</sup> | 21.27 <sup>a</sup> |
| 1949 | 31.32                | 34.41  | ---                | 39.90              | 40.81                      | 41.15  | 43.21              | 36.22              |
| 1950 | 17.70                | 18.27  | 15.28 <sup>a</sup> | 24.91              | 19.86                      | 24.94  | 21.13              | 21.10              |
| 1951 | 14.71                | 16.07  | 15.63              | 24.05 <sup>a</sup> | 24.44                      | 18.76  | 24.84              | 30.88              |
| 1952 | 12.26                | 18.24  | 23.16              | 25.56              | 26.24                      | 37.54  | 33.87              | 39.91              |
| 1953 | 10.12                | 18.34  | 21.44              | 20.61              | 17.56                      | 21.42  | 30.06              | 33.39              |
| 1954 | 19.38                | 15.60  | 14.72              | 11.92              | 13.70                      | 10.29  | 10.12              | 13.42              |
| 1955 | 26.55                | 18.36  | 20.87              | 21.21              | 18.18                      | 19.27  | 23.12              | 26.44              |
| 1956 | 7.58                 | 9.29   | 11.29              | 15.54              | 14.31                      | 12.05  | 18.41              | 18.37              |
| 1957 | 34.21                | 39.30  | 40.03              | 35.09              | 48.83                      | 52.55  | 51.88              | 46.51              |
| 1958 | 45.37                | 39.03  | 41.18              | 41.60              | 39.69                      | 40.94  | 36.40              | 39.08              |
| 1959 | 27.51                | 31.51  | 27.02              | 30.68              | 24.50                      | 35.64  | 40.45              | 43.47              |
| 1960 | 19.12                | 23.98  | 26.24              | 32.37              | 29.76                      | 32.55  | 34.28              | 45.48              |
| 1961 | 17.91                | 26.26  | 27.24              | 27.36              | 26.47                      | 25.45  | 15.70 <sup>a</sup> | 30.02              |
| 1962 | 10.87                | 14.12  | 13.58              | 17.85              | 23.90                      | 25.26  | 27.40              | 28.47              |
| 1963 | 15.07                | 16.70  | 18.99              | 18.90              | 18.65                      | 20.66  | 23.41              | 19.90              |
| 1964 | 20.75                | 22.30  | 23.78              | 28.29              | 31.88                      | 27.36  | 30.65              | 30.27              |
| 1965 | 21.48                | 26.21  | 29.41              | 30.80              | 36.65                      | 42.41  | 45.16              | 45.00              |
| 1966 | 21.63                | 20.87  | 21.54              | 29.46              | 21.44                      | 29.05  | 25.98              | 27.12              |
| 1967 | 21.95                | 20.10  | 23.89              | 30.33              | 29.26                      | 26.75  | 31.74              | 26.41              |
| 1968 | 17.26                | 25.20  | 29.88 <sup>b</sup> | 31.91              | 30.40                      | 35.14  | 35.97              | 37.13              |
| 1969 | 28.53                | 33.38  | 33.05              | 32.30              | 31.42                      | 38.07  | 33.01              | 36.59              |
| 1970 | 16.50                | 13.59  | 22.13              | 30.96              | 22.74                      | 27.79  | 35.23              | 32.30              |
| 1971 | 29.46                | 31.01  | 31.00              | 32.96              | 31.80                      | 45.24  | 29.43              | 31.10              |
| 1972 | 21.21                | 15.49  | 21.10              | 25.43              | 31.49                      | 35.09  | 42.02              | 31.90              |
| 1973 | 30.61                | 30.85  | 35.14 <sup>b</sup> | 47.82              | 52.28                      | 50.93  | 51.66              | 47.91              |
| 1974 | 18.25                | 30.94  | 20.93 <sup>b</sup> | 36.41 <sup>b</sup> | 37.00                      | 41.80  | 42.85              | 37.28 <sup>a</sup> |
| 1975 | 26.62                | 24.92  | 23.65              | 25.84 <sup>a</sup> | 25.67                      | 33.49  | 35.82              | 48.64              |
| 1976 | 34.40                | 46.04  | 40.82              | 45.21              | 39.13                      | 45.24  | 49.06              | 47.46              |
| 1977 | 15.06                | 19.90  | 17.06              | 19.40              | 29.64                      | 32.43  | 24.83              | 29.69              |
| 1978 | 19.04                | 18.48  | 21.28              | 24.64              | 35.99                      | 35.17  | 36.35 <sup>b</sup> | 33.08              |
| 1979 | 16.34                | 32.35  | 31.44              | 28.83              | 36.64                      | 39.97  | 36.72              | 38.74              |
| 1980 | 18.33                | 23.05  | 22.67              | 21.27              | 24.23                      | 39.02  | 33.69              | 29.56              |
| 1981 | 28.73                | 26.24  | 30.19              | 27.40              | 36.37                      | 41.05  | 43.23              | 49.62              |

**TABLE 3. CONTINUED.**

| Year               | Brackettville<br>22N | Uvalde             | Sabinal            | Hondo              | San Antonio<br>Intl. Airt. | Boerne             | New<br>Braunfels   | San Marcos         |
|--------------------|----------------------|--------------------|--------------------|--------------------|----------------------------|--------------------|--------------------|--------------------|
| 1982               | 19.10                | 23.35              | 18.44              | 21.99              | 22.96                      | 27.64              | 21.04              | 22.47 <sup>b</sup> |
| 1983               | 19.35                | 24.45 <sup>a</sup> | 23.33              | 20.92 <sup>b</sup> | 26.11                      | 34.60              | 34.13              | 36.95              |
| 1984               | 16.24                | 15.33 <sup>b</sup> | 20.67              | 21.19 <sup>a</sup> | 25.95                      | 26.97              | 20.90              | 8.26 <sup>b</sup>  |
| 1985               | 18.93                | 5.76 <sup>a</sup>  | 23.67              | 21.94              | 41.43                      | 37.77              | 37.26              | 33.54              |
| 1986               | 27.44                | 29.86 <sup>b</sup> | 29.62 <sup>b</sup> | 36.01 <sup>b</sup> | 42.73                      | 43.52              | 47.14              | 42.20              |
| 1987               | 39.45                | 36.39              | 38.36              | 40.09              | 37.96                      | 39.86              | 37.33 <sup>a</sup> | 37.94              |
| 1988               | 12.08                | 15.20              | 13.52              | 9.81 <sup>b</sup>  | 19.01                      | 19.49              | 16.27 <sup>b</sup> | 21.50              |
| 1989               | 16.98                | 18.65              | 17.26              | 16.10              | 22.14                      | 25.14              | 20.99              | 25.46              |
| 1990               | 38.24 <sup>b</sup>   | 24.73              | 30.06              | 27.01              | 38.31                      | 42.51              | 24.58 <sup>a</sup> | 35.14 <sup>b</sup> |
| 1991               | 23.11                | 21.77              | 31.12              | 34.55              | 42.76                      | 48.22              | 56.55              | 51.07              |
| 1992               | 22.22                | 27.85 <sup>a</sup> | 37.73              | 45.34              | 46.49                      | 64.17              | 38.84 <sup>b</sup> | 40.33 <sup>b</sup> |
| 1993               | 15.18                | 9.32 <sup>c</sup>  | 13.20              | 16.60              | 32.00                      | 24.02              | 19.54 <sup>b</sup> | 24.01 <sup>b</sup> |
| 1994               | 22.85 <sup>a</sup>   | 39.61              | 29.32              | 22.38 <sup>b</sup> | 40.42                      | 40.98              | 35.76 <sup>a</sup> | 40.85              |
| 1995               | 25.87                | 19.47              | 27.55              | 24.55              | 23.20                      | 30.29              | 23.29              | 32.57              |
| 1996               | 20.32 <sup>b</sup>   | 16.20              | 14.20              | 15.50              | 17.80                      | 24.57              | 19.00              | 28.20              |
| 1997               | ---                  | 27.77              | 35.74              | 37.54              | 33.94                      | ---                | 41.65              | 43.56              |
| 1998               | 24.15                | 27.40 <sup>b</sup> | 20.66 <sup>b</sup> | 30.44 <sup>a</sup> | 42.10                      | 45.74              | 52.98              | 58.51              |
| 1999               | 19.88                | 19.08              | 2.55 <sup>b</sup>  | 16.94              | 16.63                      | 18.67              | 21.07              | 19.38              |
| 2000               | 18.11 <sup>b</sup>   | 23.84              | 22.87              | 32.49              | 35.86                      | 46.30 <sup>a</sup> | 36.34 <sup>b</sup> | 40.56              |
| 2001               | 18.40                | 26.02              | 25.87              | 30.59              | 36.72                      | 53.91              | 37.91              | 42.41              |
| 2002               | ---                  | 36.79              | 35.75              | 44.70              | 46.27                      | 63.20              | 43.60              | 46.16              |
| 2003               | 25.19 <sup>c</sup>   | 23.39              | 24.86              | 34.70              | 28.45                      | 28.55              | 23.42              | 25.74              |
| 2004               | 40.23                | 27.76              | 37.99              | 44.76              | 45.32                      | 60.50              | 50.55              | 52.68              |
| 2005               | 25.13                | 16.48              | 20.24              | 28.90              | 16.54                      | 25.31              | 21.01              | 22.42              |
| 2006               | 14.62                | 7.85               | 11.06              | 12.15              | 21.34                      | 24.24              | 28.51              | 26.36              |
| 2007               | 39.93                | 28.89              | 37.55              | 57.58              | 47.25                      | 59.00              | 45.40              | 41.59              |
| 2008               | 12.59                | 11.23              | 14.66              | 16.18              | 13.76                      | 14.74              | 16.70              | 15.79              |
| 2009               | 14.26                | 16.19              | 20.86              | 25.00              | 30.69                      | 32.65              | 28.10              | 33.10              |
| 2010               | 23.78                | 18.86              | 27.13              | 27.32              | 37.39                      | 42.06              | 37.03              | 27.58 <sup>b</sup> |
| 2011               | 12.98                | 9.91               | 13.81              | 15.27              | 17.58                      | 17.76              | 19.25 <sup>a</sup> | 19.39 <sup>b</sup> |
| 2012               | 20.35 <sup>a</sup>   | 13.97              | 18.70              | 25.96              | 39.30                      | 29.78              | 35.49              | 34.26              |
| 2013               | 21.18 <sup>a</sup>   | 22.75              | 22.87              | 19.48 <sup>a</sup> | 31.99                      | 28.95              | 32.88              | 31.30              |
| 2014               | 18.92 <sup>a</sup>   | 21.09              | 20.62              | 17.84 <sup>a</sup> | 28.20                      | 29.00              | 23.17              | 23.84              |
| 2015               | 26.20 <sup>a</sup>   | ---                | 41.62              | 32.90 <sup>a</sup> | 42.22                      | 50.09              | 43.45              | 52.29              |
| 2016               | 43.34 <sup>a</sup>   | ---                | 32.04              | 38.94 <sup>a</sup> | 43.92                      | 39.70              | ---                | 49.91 <sup>a</sup> |
| 2017               | 20.03                | ---                | 27.14              | 24.32              | 27.33                      | 28.84              | ---                | 42.56              |
| Years of<br>Record |                      | 81                 |                    | 84                 | 84                         | 83                 | 82                 | 84                 |
| Mean               |                      | 23.06              |                    | 28.72              | 30.61                      | 34.14              | 33.05              | 35.32              |
| Median             |                      | 22.67              |                    | 27.85              | 30.43                      | 32.73              | 33.69              | 33.44              |

Data sources: U.S. Department of Commerce; Uvalde data: Texas A&M AgriLIFE Extension Service.

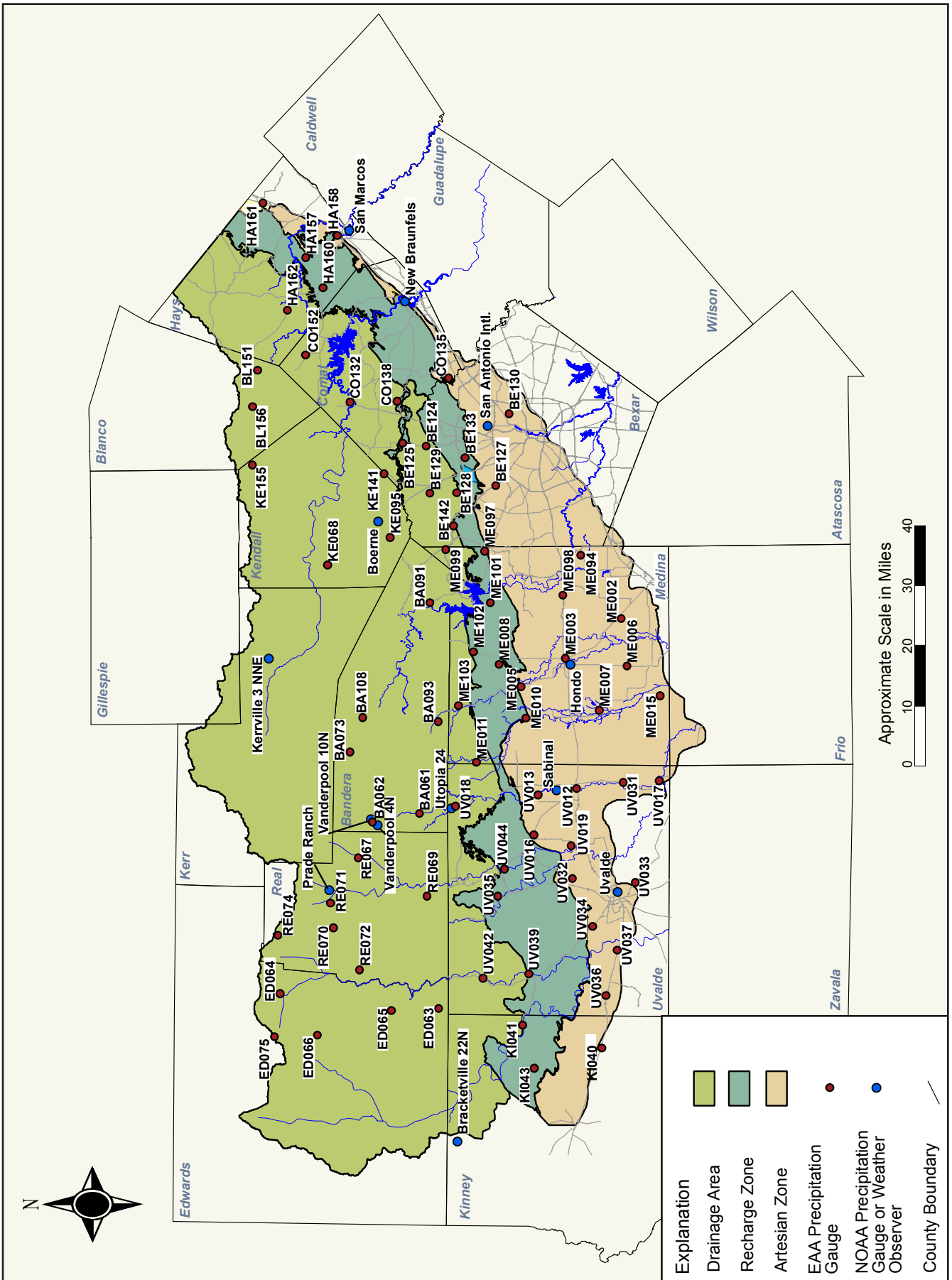
<sup>a</sup> = Partial record not included in long-term mean or median; missing one month.

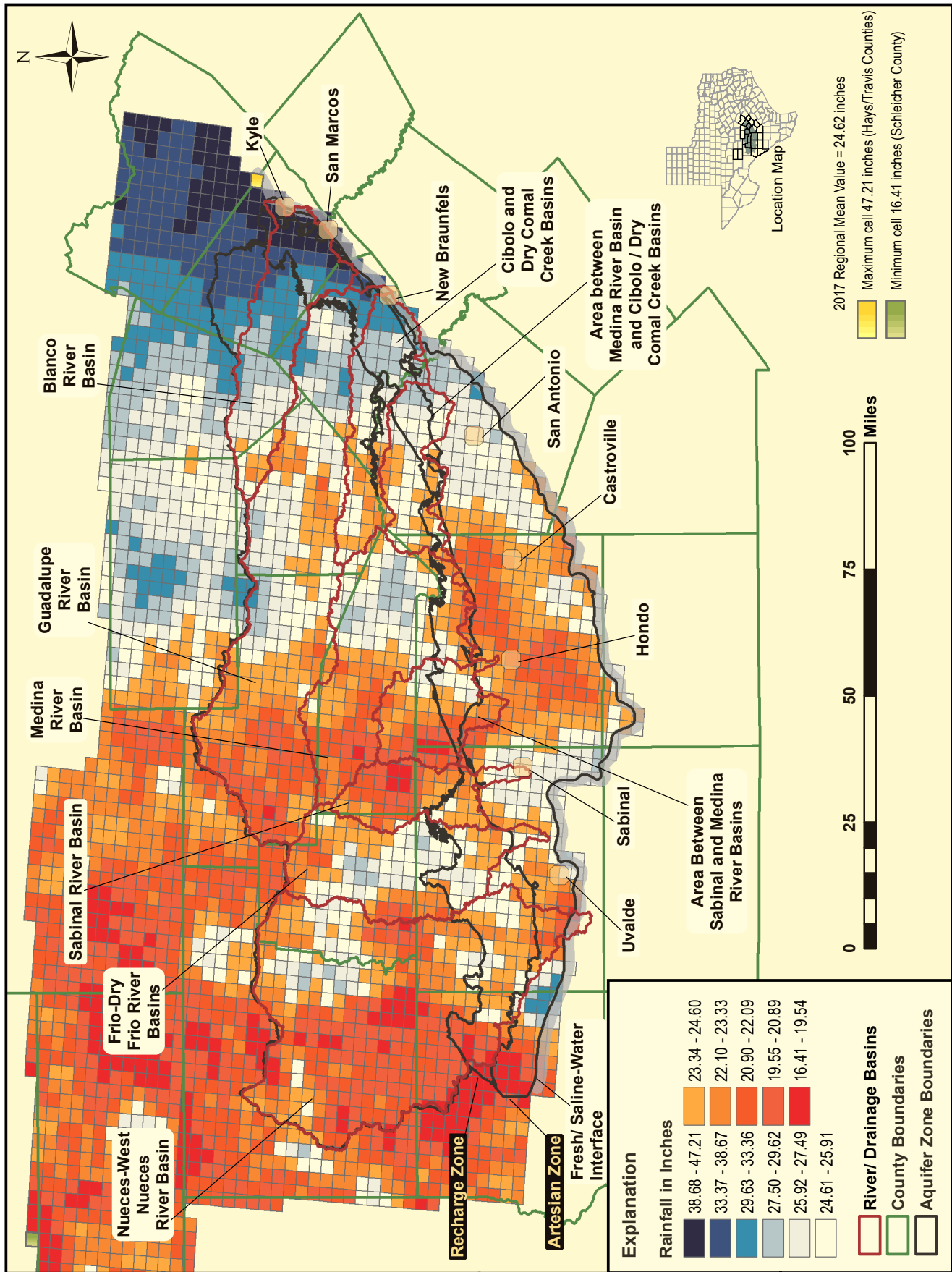
<sup>b</sup> = Partial record not included in long-term mean or median; missing more than one month.

<sup>c</sup> = Change in gauge location from previous years.

--- = No data available.

Mean and median values calculated using only years with full records. Years with partial or missing records discarded from data set.





**Figure 2.** Gauge-Calibrated NEXRAD Rainfall Distribution for 2017.