HARRIS-GALVESTON
SUBSIDENCE
DISTRICT

2023 ANNUAL GROUNDWATER REPORT

Groundwater Withdrawal and Subsidence in Harris and Galveston Counties

EXECUTIVE SUMMARY

Harris-Galveston Subsidence District Report 2024-01

Harris-Galveston Subsidence District
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Executive Summary

In the greater Houston region, groundwater was the primary source of water for municipal, agricultural, and industrial users over the last century. The rapid and large population growth in the 1950s led to a dramatic increase in water demand and groundwater withdrawal. The reliance on groundwater and significant subsidence that resulted from this abundant groundwater withdrawal led to the creation of the Harris-Galveston Subsidence District (District) in 1975 by the Texas Legislature. The District's mission is to regulate groundwater use in Harris and Galveston counties to prevent further subsidence.

This report comprises the 48th Annual Groundwater Report for the District. Pursuant to District Resolution No. 2024-1110 passed on February 14, 2024, the Board of Directors held a public hearing at 9:00 a.m. on April 25, 2024, to present climatic conditions, groundwater use, groundwater levels and measured subsidence within the District for the 2023 calendar year. This report provides an overview of the information presented during the public hearing.

Description of Study Area

Harris and Galveston counties withdraw groundwater from the Gulf Coast Aquifer System, which includes two primary water-bearing units: the shallow, hydrologically connected system of the Chicot-Evangeline (undifferentiated) aquifers and the deeper Jasper aquifer. The regionally confining Burkeville unit separates the shallow and deeper systems. Only a small percentage of the total groundwater withdrawn within the District comes from the Jasper aquifer; consequently, most of the subsidence that has occurred in the District can be sourced to clay compaction in the shallow water-bearing unit of the Chicot-Evangeline (undifferentiated).

The District's Regulatory Plan was developed to reduce groundwater withdrawal to a level that ceases ongoing subsidence and prevents future subsidence within the District. Since 1999, the District has been separated into three regulatory areas (**Figure 1**). Utilizing a novel regulatory approach, the amount of groundwater that may be used by a permittee is dependent upon their total water demand and location within a specific regulatory area. Regulatory Area One permittees can produce groundwater for up to 10 percent of their total water demand; whereas, Regulatory Areas Two and Three permittees can produce groundwater for up to 20 percent of their total water demand unless they are in a certified groundwater reduction plan.

The District's Regulatory Plan requires permittees to convert to alternative water supplies in order to reduce their reliance on groundwater sources. The primary alternative water supply is surface water sourced from three river basins: the Brazos River Basin, the San Jacinto River Basin and the Trinity River Basin.

In the 1950s, the City of Houston along with other entities in the region began the development of several water supply reservoirs within the San Jacinto and Trinity River Basins to provide water for the rapidly growing area. Today, water treatment plants served by these surface water sources are operated by the City of Houston, the City of Sugar Land, the City of Richmond, the Gulf Coast Water Authority, the Brazosport Water Authority, and others.

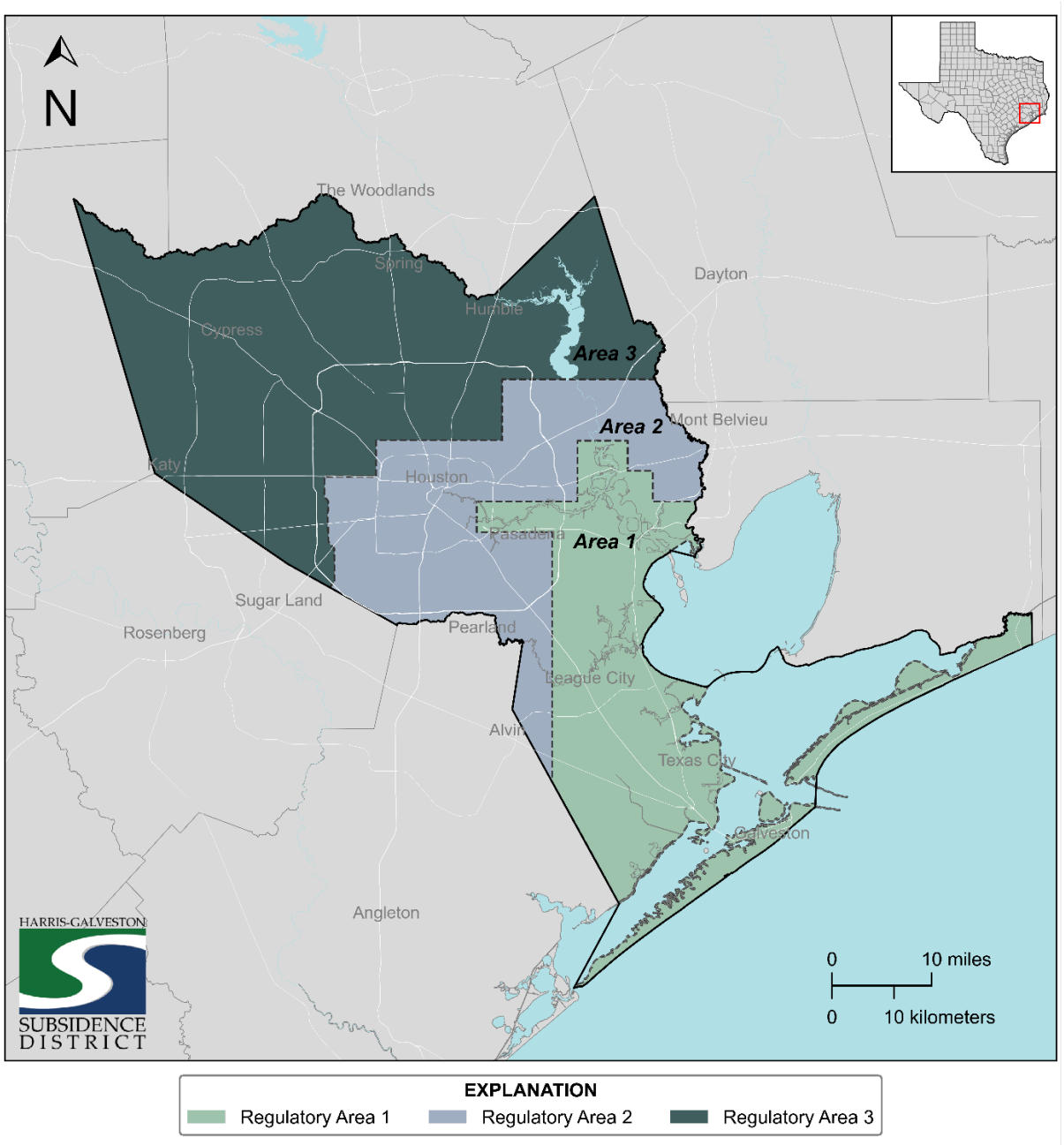

Figure 1: Location of the Harris-Galveston Subsidence District Regulatory Areas.

Climate

Annual variations in precipitation can significantly impact the amount of water used (i.e., total water demand) in the District. Groundwater use patterns fluctuate based on total rainfall received, which results in changes in aquifer water levels and, potentially, in land subsidence. During periods of excessive rainfall, total water demand can decline; conversely, during periods of drought, water use can increase, resulting in declining water levels in the aquifer and increased land subsidence. The 2023 calendar year began with below normal rainfall for half of the National Weather Service (NWS) climate stations analyzed for the region. The year progressed with five out of the eight stations recording below the 1991-2020 average normal precipitation and worsened in the summer months (**Figure 2**). From August through December, an extreme drought

was classified for the region and all climate stations ended 2023 with rainfall accumulations below normal with six stations measuring over 15 inches below normal. This was similar to the drought experienced in 2022 as the majority of analyzed climate stations measured below normal rainfall from the summer through end of year.

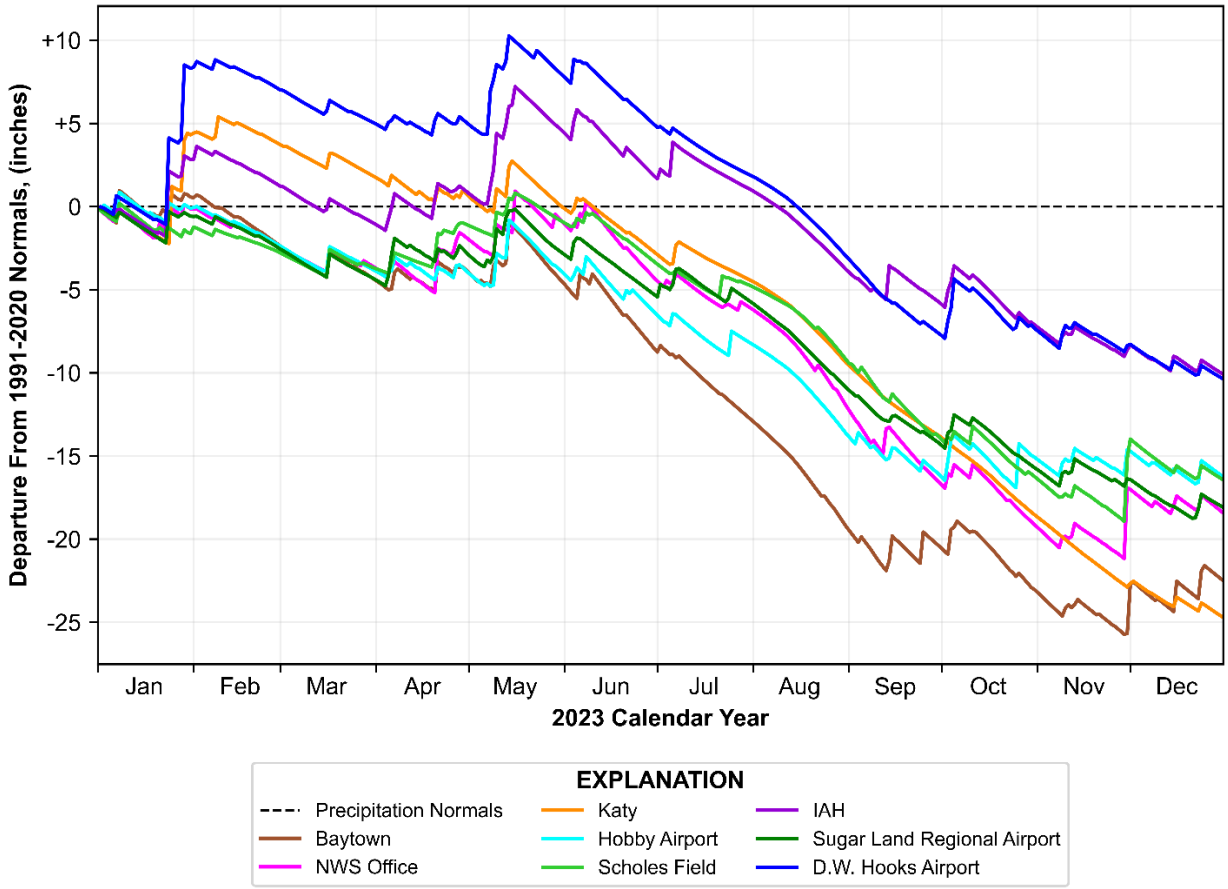

Figure 2: Cumulative 2023 precipitation departure from 1991-2020 normals precipitation, in inches, at select NWS climate stations within and surrounding the District.
Source: https://www.ncei.noaa.gov/access.

Water Use

Since 1976, water users in the District have been working to change their primary source of water from groundwater to alternative water as required by the District's Regulatory Plan to prevent subsidence. The percentage of total water demand sourced from groundwater has decreased from about 61 percent in 1976 to about 24 percent in 2023. The majority of groundwater use, approximately 85 percent, occurs in Regulatory Area Three, where the regulatory compliance timeline will not be completed until 2035. The three primary water uses in the District are public supply, industrial, and irrigation. The overall groundwater use within the District in 2023 is 258.6 million gallons per day (MGD), which is a two percent increase from 2022 (**Figure 3**). Groundwater used for public supply remains the largest use category at about 237.3 MGD, a two percent increase from the previous year, and accounts for approximately 91 percent of all groundwater used in the District.

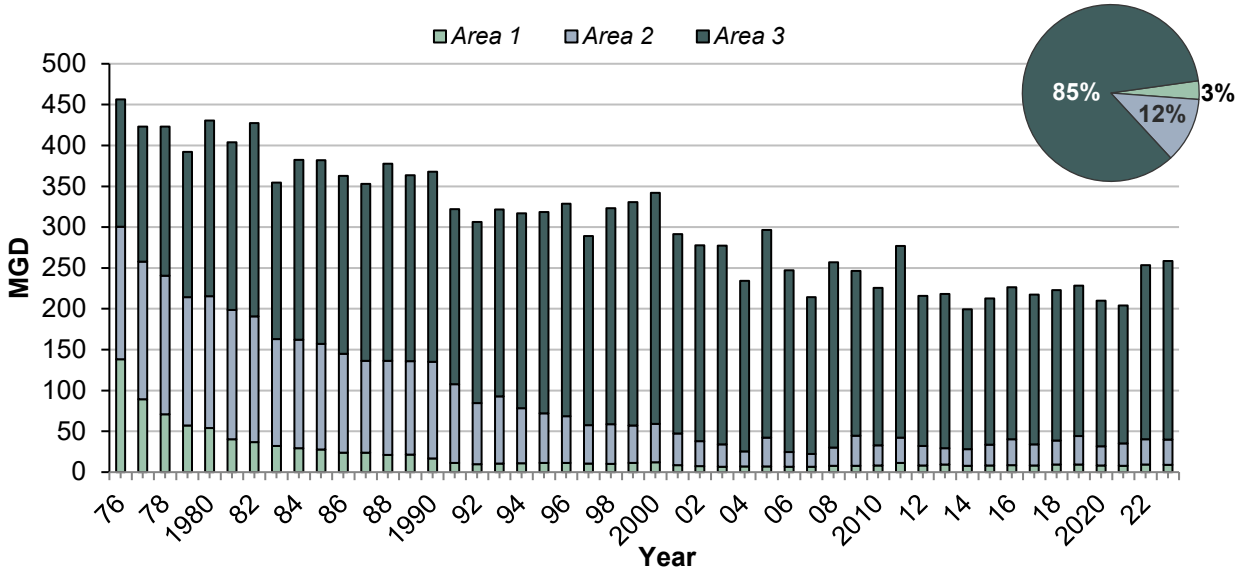

Figure 3*:* Groundwater withdrawals, in million gallons per day (MGD), by regulatory area from 1976 to 2023. The total groundwater used in the District was 258.6 MGD in 2023 with the majority used in Area Three**.**

The District's Regulatory Plan requires permittees to convert to alternative water sources in order to reduce their reliance on groundwater. The primary alternative water supply used in the District is treated surface water sourced from three river basins: the Brazos River Basin, the San Jacinto River Basin and the Trinity River Basin. In 2023, the total alternative water used was 819.1 MGD, with the Trinity River remaining the single largest source of alternative water at 70 percent of the total and provided about 550.4 MGD in surface water supply. Groundwater remains the second largest source of water supply representing approximately 24 percent of the total water demand in 2023. The total water demand for the District was 1,077.7 MGD in 2023, which is about one percent higher than the reported water use in the previous year. (**Figure 4**).

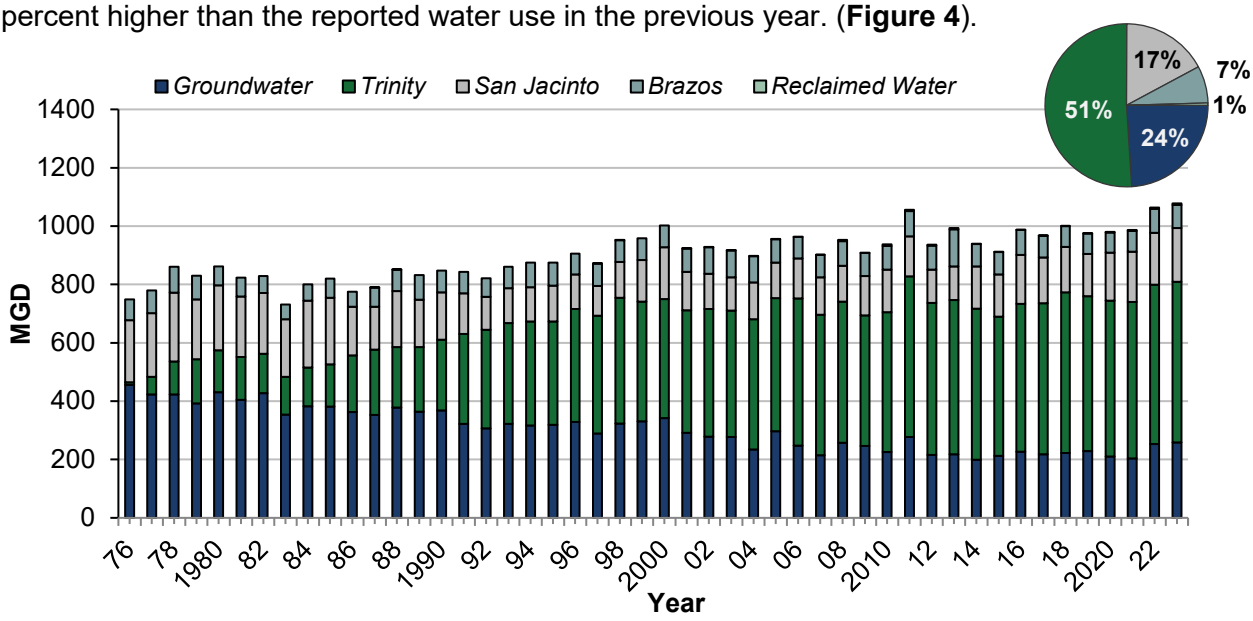

Figure 4: Total water use for the District, in million gallons per day (MGD), by source water, from 1976 to 2023. The reported total water used in the District in 2023 was 1,077.7 MGD.

Groundwater Levels

Annually, since 1975, the United States Geological Survey (USGS) has measured the aquifer potentiometric water level (water-level) in hundreds of wells throughout southeast Texas in cooperation with the District through a joint funding agreement along with additional cities, subsidence districts and groundwater conservation districts. These data are used to monitor the water-level altitude for the Chicot/Evangeline and Jasper aquifers and evaluate the temporal change in water level. Since aquifer water-level is the best measure of the pressure in the aquifer, this information is also of vital importance to understanding how groundwater pumping may stress the aquifer and its resulting impacts on land subsidence.

The change in water-level in the Chicot-Evangeline (undifferentiated) aquifer from 1977 to 2024 highlights the impact of District regulation on the aquifer (**Figure 5**). Generally, Regulatory Areas One and Two have seen a substantial rise in the water-level of over 200 feet (60 meters) in the Chicot-Evangeline (undifferentiated) aquifer measured in areas like the Houston Ship Channel. The area of rise is a result of the reduction of groundwater use required by the District's Regulatory Plan. Conversely, in Regulatory Area Three, water-levels measured in 2023 were consistently lower than the 1977 benchmark water-levels, with some declines over 320 feet (97.5 meters) in the Chicot-Evangeline (undifferentiated) aquifer in northern Harris County. These areas are growing rapidly and the conversion to alternative sources of water will not be completed until 2035. The highest historical water-level declines were measured in south-central Montgomery County, with over 390 feet (118.9 meters) around The Woodlands.

Subsidence

Since the 1990s, the District has developed a subsidence monitoring network utilizing global positioning system (GPS) technology to monitor land surface deformation within and surrounding the District. This network involves collaboration amongst GPS station operators such as the Fort Bend Subsidence District, the University of Houston, the Lone Star Groundwater Conservation District, the Brazoria County Groundwater Conservation District, Texas Department of Transportation, and other local entities. The subsidence monitoring network includes over 190 active GPS stations throughout southeast Texas in 2023.

The District estimates the average annual subsidence rate as the linear regression of the change in ellipsoidal height, which represents the vertical movement in the GPS data collected from the GPS stations, from the five most current years (i.e., 2019 through 2023). The subsidence rates observed in Regulatory Areas One and Two are stable, since both areas have reached their full regulatory conversion level, and Chicot-Evangeline (undifferentiated) water-levels have risen (**Figure 6**). Subsidence rates are generally above 0.5 centimeters per year throughout Regulatory Area Three, as groundwater is still the primary water source in this area, and Chicot-Evangeline (undifferentiated) water-levels have significantly declined. The highest subsidence rates were measured at GPS stations in the Katy and Fulshear area at over two centimeters per year.

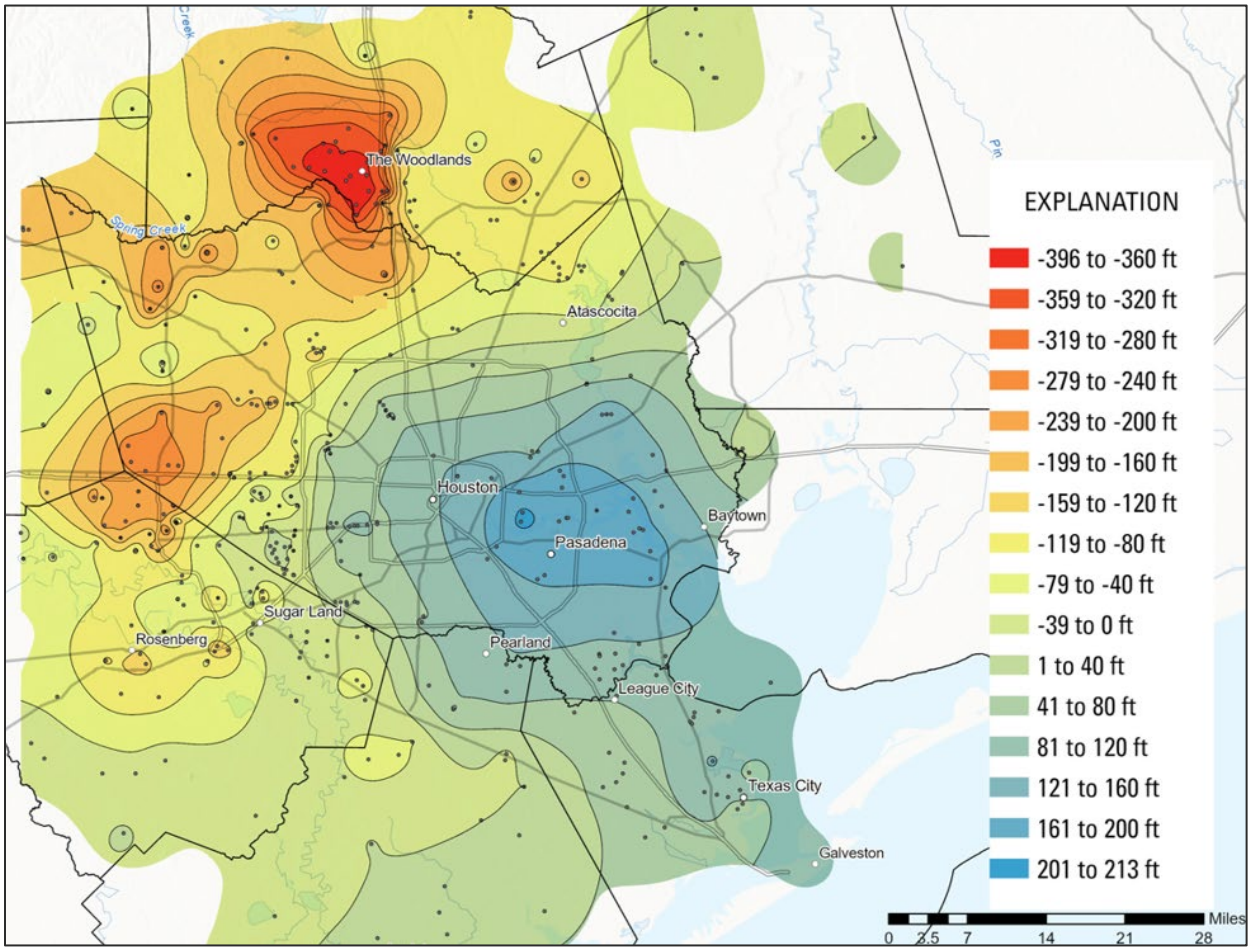

Figure 5: Potentiometric water level change at wells screened in the Chicot-Evangeline (undifferentiated) aquifer, Houston region, Texas, from 1977 to 2024 (Source: USGS provisional data – preliminary and subject to change).

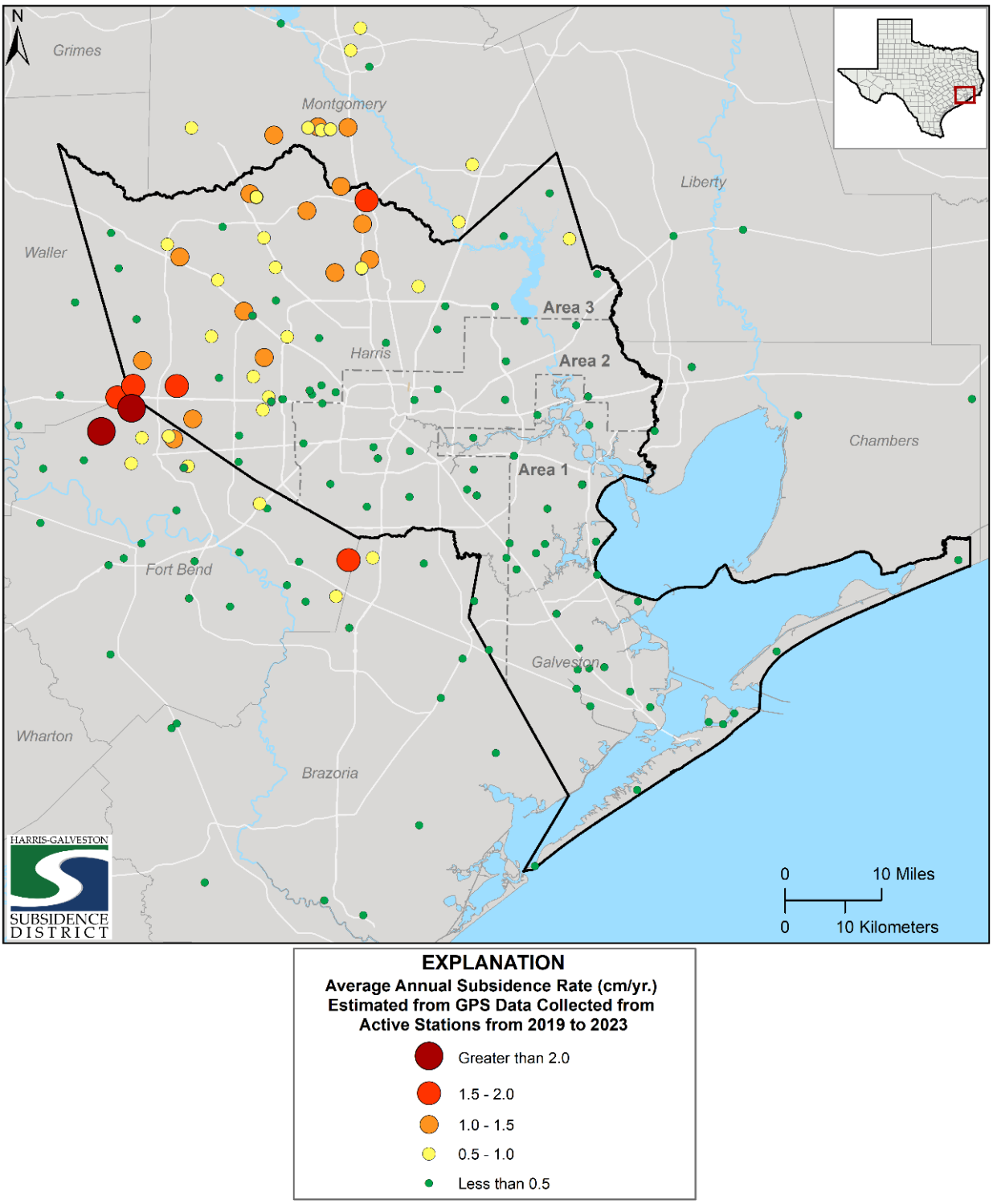

Figure 6: Annual subsidence rate, measured in centimeters per year, from 2019 to 2023, referenced to Houston20 and estimated from three or more years of GPS data collected from active GPS stations in Harris, Galveston, and surrounding counties, Texas.

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