Prepared in cooperation with the Harris-Galveston Subsidence District, City of Houston, Fort Bend Subsidence District, Lone Star Groundwater Conservation District, and Brazoria County Groundwater Conservation District

Status of Groundwater-Level Altitudes and Long-Term Groundwater-Level Changes in the Chicot, Evangeline, and Jasper Aquifers, Houston-Galveston Region, Texas, 2019

Scientific Investigations Report 2019–5089

U.S. Department of the Interior
U.S. Geological Survey

Cover. Front, left to right: Photographs showing production well at U.S. Geological Survey (USGS) site 293005095151801 (station KH-65-32-902) in Galveston County, Texas, February 4, 2019; production well at USGS site 294720095474301 (station LJ-65-10-8XX) in Harris County, Texas, February 12, 2019; and production well at USGS site 295235095414301 (station LJ-65-03-810) in Harris County, Texas, February 12, 2019.

Back: USGS hydrologic technician measuring depth to groundwater at a production well at USGS site 301449095312801 (station TS-60-52-3ZZ) in Montgomery County, Texas, March 8, 2019.

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Contents

Figures

Conversion Factors

U.S. customary units to International System of Units

Multiply	By	To obtain
	Length	
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
	Area	
square mile (mi^2)	2.590	square kilometer (km^2)
	Transmissivity	
foot squared per day (ft^2/d)	0.09290	meter squared per day (m^2/d)

International System of Units to U.S. customary units

Multiply	By	To obtain
	Length	
meter (m)	3.281	foot (ft)
meter (m)	1.094	yard (yd)

Datum

Vertical coordinate information is referenced to either the National Geodetic Vertical Datum of 1929 (NGVD 29) or the North American Vertical Datum of 1988 (NAVD 88).

Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83).

Abbreviations

BCGCD Brazoria County Groundwater Conservation District

DEM digital elevation model

FBSD Fort Bend Subsidence District

GIS geographic information system

HGSD Harris-Galveston Subsidence District

LSGCD Lone Star Groundwater Conservation District

NWIS National Water Information System

USGS U.S. Geological Survey

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By Christopher L. Braun, Jason K. Ramage, and Sachin D. Shah

Abstract

Since the early 1900s, most of the groundwater withdrawals in the Houston-Galveston region, Texas, have been from the three primary aquifers that compose the Gulf Coast aquifer system—the Chicot, Evangeline, and Jasper aquifers. Withdrawals from these aquifers are used for municipal supply, commercial and industrial use, and irrigation. This report, prepared by the U.S. Geological Survey in cooperation with the Harris-Galveston Subsidence District, City of Houston, Fort Bend Subsidence District, Lone Star Groundwater Conservation District, and Brazoria County Groundwater Conservation District, is one in an annual series of reports depicting the status of groundwater-level altitudes and long-term groundwater-level changes in the Chicot, Evangeline, and Jasper aquifers in the Houston-Galveston region. This report contains regional-scale maps depicting approximate 2019 groundwater-level altitudes (represented by measurements made during December 2018 through March 2019) and long-term groundwater-level changes in the Chicot, Evangeline, and Jasper aquifers.

In 2019, groundwater-level-altitude contours for the Chicot aquifer ranged from 200 feet (ft) below the North American Vertical Datum of 1988 (hereinafter referred to as “datum”) to 200 ft above datum. The 1977–2019 groundwater-level-change contours for the Chicot aquifer depict a large area of decline in groundwater-level altitudes (100 ft) in northwestern Harris County. The largest rise in groundwater-level altitudes in the Chicot aquifer from 1977 to 2019 (200 ft) was in southeastern Harris County.

In 2019, groundwater-level-altitude contours for the Evangeline aquifer ranged from 300 ft below datum to 200 ft above datum. The 1977–2019 groundwater-level-change contours for the Evangeline aquifer depict broad areas where groundwater-level altitudes either declined or rose. The largest decline in groundwater-level altitudes (280 ft) was in southern Montgomery and northern Harris Counties. The largest rise in groundwater-level altitudes in the Evangeline aquifer from 1977 to 2019 (240 ft) was in southeastern Harris County.

In 2019, groundwater-level-altitude contours for the Jasper aquifer ranged from 200 ft below datum to 250 ft above datum. The 2000–19 groundwater-level-change contours for the Jasper aquifer depict groundwater-level declines throughout most of the study area where groundwater-level-altitude data from the Jasper aquifer were collected, with the largest decline (200 ft) in southern Montgomery County.

Introduction

The Houston-Galveston region, Texas, includes portions of 11 counties (Harris, Galveston, Fort Bend, Montgomery, Brazoria, Chambers, Grimes, Liberty, San Jacinto, Walker, and Waller) and is approximately 11,000 square miles (fig. 1). Groundwater withdrawn from the three primary aquifers that compose the Gulf Coast aquifer system—the Chicot, Evangeline, and Jasper aquifers—has been the primary source of water for municipal supply, commercial and industrial use, and irrigation in the Houston-Galveston region since the early 1900s (Kasmarek and Robinson, 2004). Prior to 1975, the withdrawal of groundwater from the Chicot and Evangeline aquifers was unregulated, and water levels in the aquifers were declining annually, resulting in land-surface subsidence in the Houston-Galveston region (Coplin and Galloway, 1999). By 1977, the withdrawals had resulted in groundwater-level-altitude declines in southeastern Harris County of 300 and 350 feet (ft) below the North American Vertical Datum of 1988 (NAVD 88; hereinafter referred to as “datum”) in the Chicot and Evangeline aquifers, respectively (Gabrysch, 1979).

To regulate and reduce groundwater withdrawals in Harris and Galveston Counties, the 64th Texas State Legislature authorized the establishment of the Harris-Galveston Subsidence District (HGSD) in 1975 (Harris-Galveston Subsidence District, 2013). After establishing the HGSD, the Texas State Legislature established an additional subsidence district (Fort Bend Subsidence District [FBSD]) and two groundwater conservation districts (Lone Star Groundwater Conservation District [LSGCD] and Brazoria County Groundwater Conservation District [BCGCD]) in the Houston-Galveston region to enable the regulation of groundwater withdrawals within their respective jurisdictions.

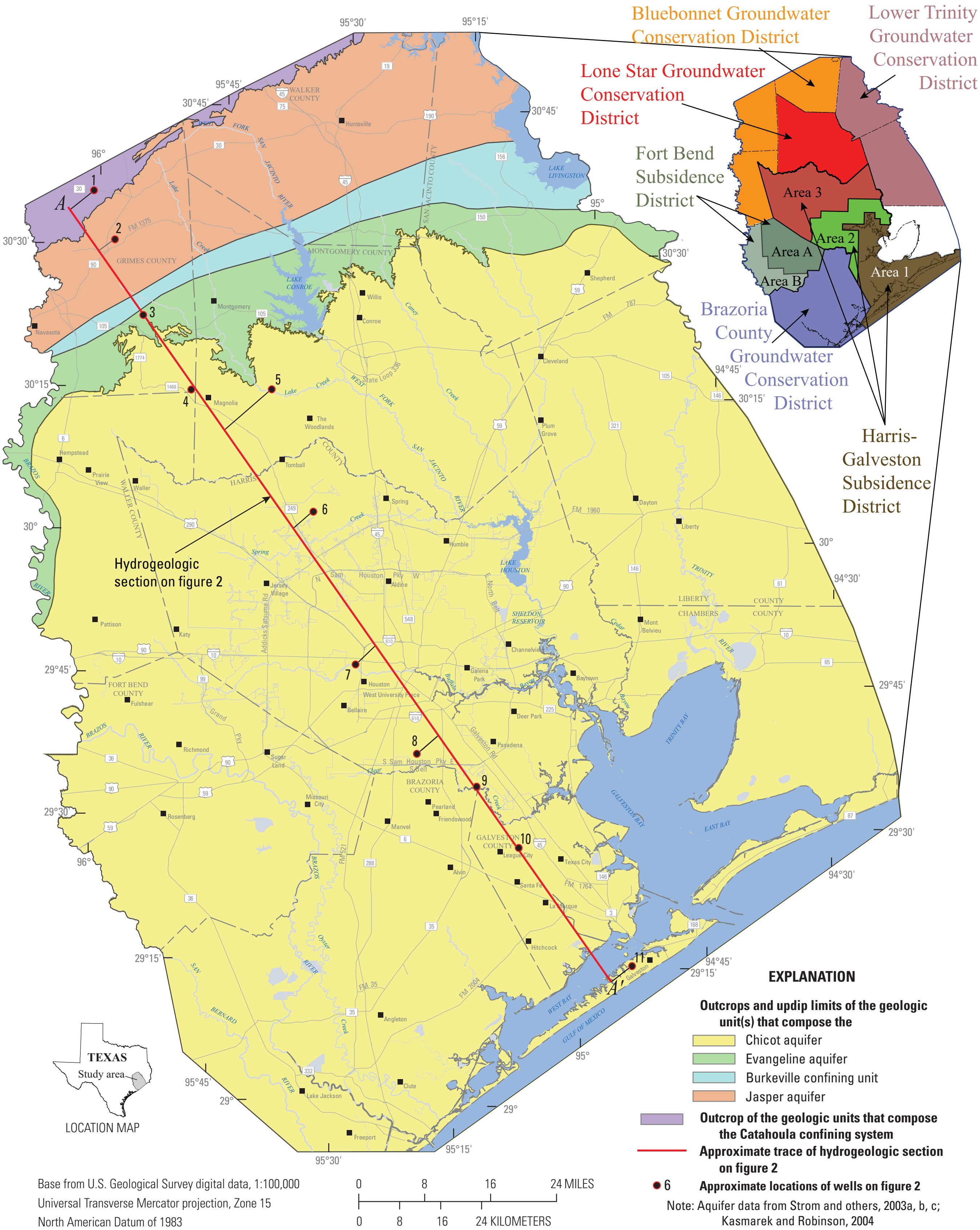


Figure 1. Locations of groundwater regulatory districts; approximate trace of hydrogeologic cross section *A*–*A*′; and outcrops and updip limits of the hydrogeologic units in the Gulf Coast aquifer system in the Houston-Galveston region study area, Texas (modified from Strom and others, 2003a, b, c; Kasmarek and Robinson, 2004).

The FBSD was established by the 71st Texas State Legislature in 1989 (Fort Bend Subsidence District, 2019), the LSGCD and Bluebonnet Groundwater Conservation District were established by the 77th Texas State Legislature in 2001 (Lone Star Groundwater Conservation District, 2019a; Bluebonnet Groundwater Conservation District, 2019), and the BCGCD was established by the 78th Texas State Legislature in 2003 (Brazoria County Groundwater Conservation District, 2019). Regulatory plans to gradually decrease groundwater withdrawals (in conjunction with increased usage of alternative surface-water supplies) are currently (2019) being phased in throughout most of the study area (fig. 1). The current groundwater management plans of each district are available on their respective websites (Bluebonnet Groundwater Conservation District, 2013; Fort Bend Subsidence District, 2013; Harris-Galveston Subsidence District, 2013; Lower Trinity Groundwater Conservation District, 2014; Brazoria County Groundwater Conservation District, 2017; Lone Star Groundwater Conservation District, 2019b). Groundwater withdrawals are currently (2019) not being regulated by a groundwater conservation district in one county in the Houston-Galveston region (Chambers County).

Since the 1970s, the U.S. Geological Survey (USGS), in cooperation with the HGSD and additional subsidence and groundwater conservation districts (FBSD, LSGCD, and BCGCD) as they became operational, has been monitoring groundwater-level altitudes and publishing reports on the status of groundwater-level altitudes and long-term groundwater-level changes in the Houston-Galveston region. An extensive well-monitoring network was first established by the USGS in 1977, and water-level data were collected and used to create the first published water-level-altitude maps of the Chicot and Evangeline aquifers in the Houston-Galveston region (Gabrysch, 1979). A comprehensive water-level-altitude report for the Chicot and Evangeline aquifers was first published by the USGS in 1991 (Barbie and others, 1991). The USGS also first published a water-level-altitude map in 2001 of the Jasper aquifer in the Houston-Galveston region (Coplin, 2001). Additional information on the history of groundwater-level-altitude monitoring and of the USGS reports published to document groundwater-level altitudes and changes in groundwater-level altitudes in the Houston-Galveston region is provided in Kasmarek and Ramage (2017).

Purpose and Scope

The purpose of this report, prepared by the USGS in cooperation with the HGSD, City of Houston, FBSD, LSGCD, and BCGCD, is to depict groundwater-level altitudes and long-term groundwater-level changes in the Chicot, Evangeline, and Jasper aquifers in the Houston-Galveston region. An overview of the hydrogeology of the study area is provided. Regional-scale maps depicting contoured groundwater-level altitudes for 2019 and depicting long-term groundwater-level changes in the Chicot and Evangeline aquifers (1977–2019) and the Jasper aquifer (2000–19) are featured. Individual groundwater-level altitudes measured at each well for all three aquifers that were assessed (Chicot, Evangeline, and Jasper aquifers) and associated metadata are available for download in companion data releases (Ramage and Shah, 2019; Ramage and Braun, 2019).

Hydrogeology of the Study Area

The following overview of the hydrogeology of the study area is summarized from Kasmarek and Ramage (2017). The three primary aquifers in the Gulf Coast aquifer system in the Houston-Galveston region study area (the Chicot, Evangeline, and Jasper aquifers) are composed of laterally discontinuous deposits of gravel, sand, silt, and clay (Baker, 1979). The percentage of clay and other fine-grained, clastic material generally increases downdip (Baker, 1979). The uppermost aquifer, the Chicot aquifer, is contained in Holocene- and Pleistocene-age (Quaternary-age) sediments; the underlying Evangeline aquifer is contained in Pliocene- and Miocene-age sediments; and the most deeply buried of the three aquifers, the Jasper aquifer, is contained in Miocene-age sediments (fig. 2) (Baker, 1979, 1986). Hydrogeologic units in the study area include the Chicot aquifer, Evangeline aquifer, Burkeville confining unit, Jasper aquifer, and Catahoula confining system (fig. 3). The stratigraphic relations between these hydrogeologic units are shown on hydrogeologic cross section *A–A′* (figs. 1 and 2) of the Gulf Coast aquifer system, which extends through the Houston-Galveston region from northwestern Grimes County southeastward through Montgomery and Harris Counties before terminating at the coast in Galveston County.

Through time, geologic and hydrologic processes created accretionary sediment wedges (stacked sequences of sediments) more than 7,600 ft thick at the coast (fig. 2) (Chowdhury and Turco, 2006). The sediments composing the Gulf Coast aquifer system were deposited by fluvial-deltaic processes and subsequently were eroded and redeposited by worldwide episodic changes in sea level that occurred as a result of oscillations between glacial and interglacial climate conditions (Lambeck and others, 2002). The Gulf Coast aquifer system consists of hydrogeologic units that dip and thicken from northwest to southeast (fig. 2); the hydrogeologic units representing the aquifers and confining units thus crop out in bands inland from and approximately parallel to the coast and become progressively more deeply buried and confined toward the coast (fig. 2) (Kasmarek, 2013). The aquifers receive recharge where the hydrogeologic units composing the aquifers crop out (Kasmarek and Robinson, 2004; fig. 2). The Burkeville confining unit is stratigraphically positioned between the Evangeline and Jasper aquifers (fig. 2), thereby restricting groundwater flow between these two aquifers. There is no confining unit between the Chicot and Evangeline aquifers (fig. 2); therefore, these two aquifers are hydraulically connected, which allows groundwater flow between them.

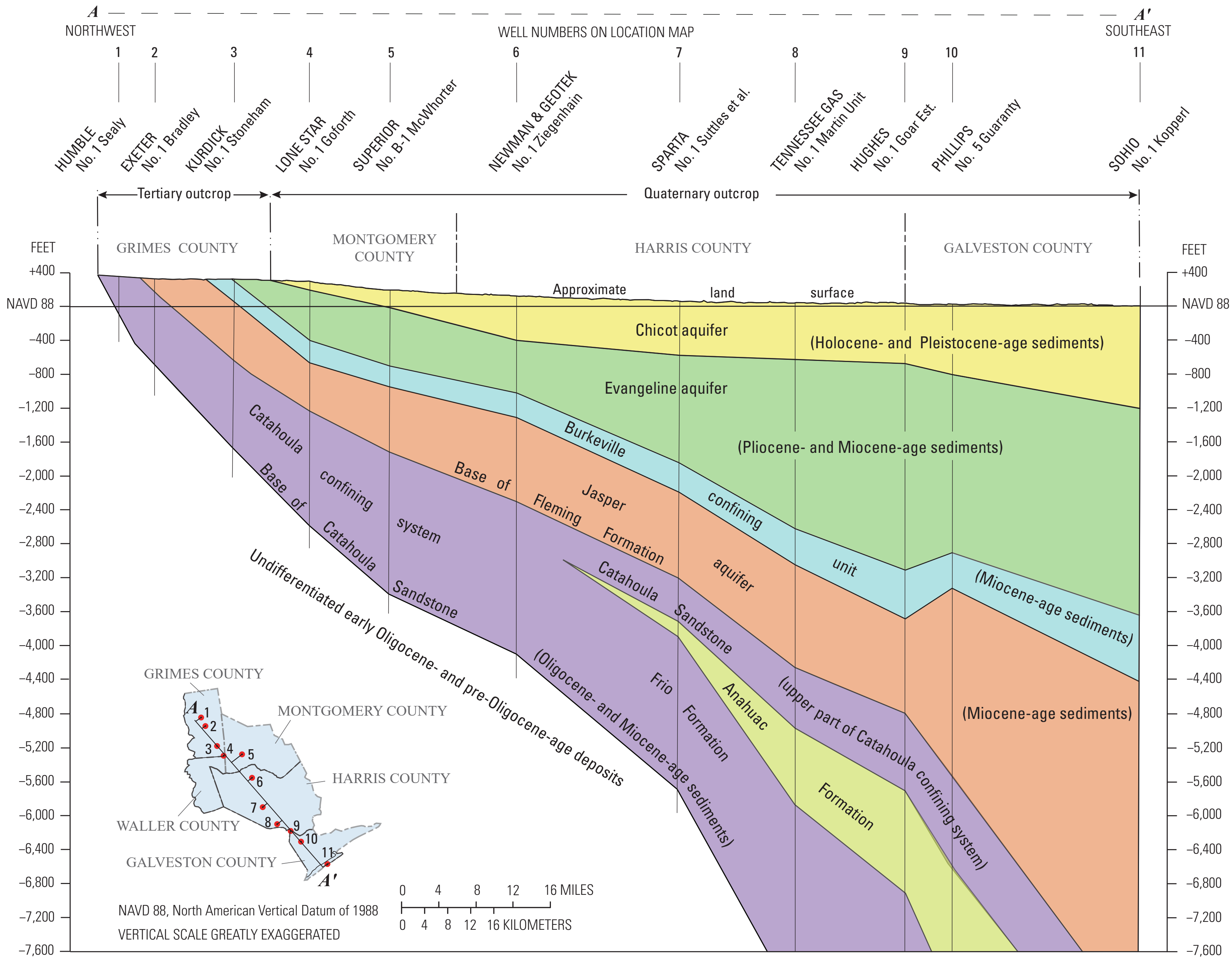
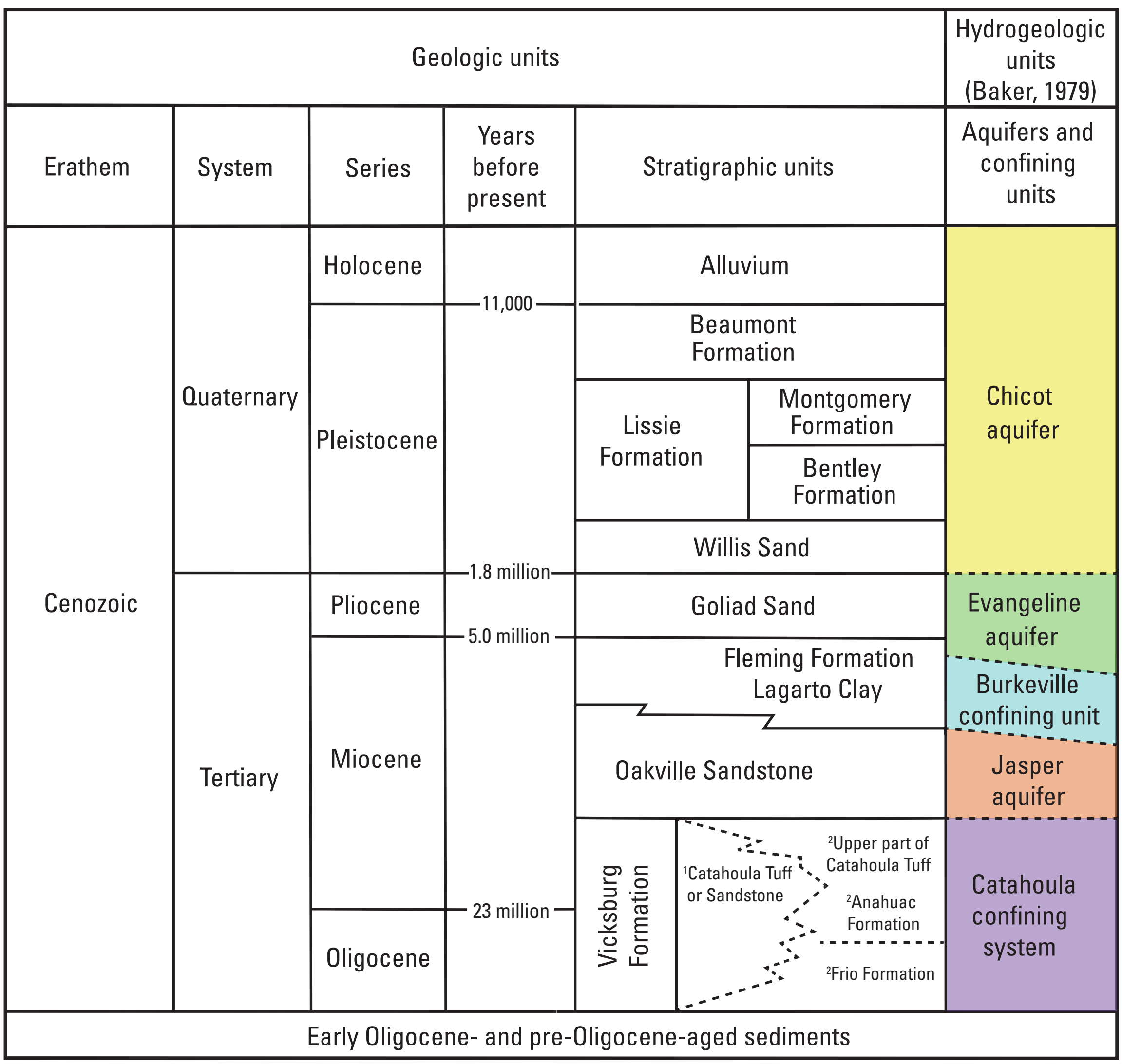


Figure 2. Hydrogeologic cross section *A–A′* of the Gulf Coast aquifer system in Grimes, Montgomery, Harris, and Galveston Counties, Texas (modified from Baker, 1979, fig. 4).

Because of this hydraulic connection, groundwater-level changes that occur in one aquifer can affect groundwater levels in the adjoining aquifer (Kasmarek and Robinson, 2004). Supporting evidence of the interaction of groundwater flow between the Chicot and Evangeline aquifers includes the differences between long-term groundwater-level-change maps, which indicate that the areas where water levels have risen or declined are approximately spatially coincident. Additional evidence of the hydraulic connection between the Chicot and Evangeline aquifers is provided by Borrok and Broussard (2016, p. 330); their geochemical evaluation of the Chicot aquifer system in Louisiana indicated that, in some years, certain wells screened in the Chicot aquifer “appeared to be tapping water with a geochemistry (temperature, salinity, alkalinity, [and so forth]) matching the underlying Evangeline aquifer.”

Hydraulic properties of the Chicot aquifer do not differ appreciably from those of the hydrogeologically similar Evangeline aquifer but can be differentiated on the basis of hydraulic conductivity (Carr and others, 1985, p. 10). From aquifer-test data, Meyer and Carr (1979) estimated that the transmissivity of the Chicot aquifer ranges from 3,000 to 25,000 feet squared per day (ft^2/d) and that the transmissivity of the Evangeline aquifer ranges from 3,000 to 15,000 ft^2/d. The Quaternary-age sediments composing the Chicot aquifer extend inland from the Gulf of Mexico and terminate at the northernmost updip limit of these sediments. Proceeding updip and inland of the Quaternary-age sediments composing the Chicot aquifer, the older geologic units (composing the Evangeline aquifer, the Burkeville confining unit, the Jasper aquifer, and the Catahoula confining system) sequentially outcrop (fig. 1). In the updip areas of the Jasper aquifer, the



[1]Located in the outcrop.
[2]Located in the subcrop.

Figure 3. Geologic and hydrogeologic units of the Gulf Coast aquifer system in the Houston-Galveston region study area, Texas (modified from Sellards and others, 1932; Baker, 1979; Meyer and Carr, 1979).

aquifer can be differentiated from the Evangeline aquifer on the basis of the depths to water below land-surface datum, which are shallower (closer to land surface) in the Jasper aquifer compared to those in the Evangeline aquifer. Additionally, in the downdip parts of the aquifer system, the Jasper aquifer can be differentiated from the Evangeline aquifer on the basis of stratigraphic position relative to the elevation of the Burkeville confining unit (figs. 2 and 3).

Precipitation falling on the land surface overlying these aquifers returns to the atmosphere as evapotranspiration, discharges to streams, or infiltrates as groundwater recharge to the unconfined updip sediments composing the aquifers. The infiltrating water moves downgradient toward the coast, reaching the intermediate and deep zones of the aquifers southeastward of the outcrop areas, where it can be withdrawn and discharged by wells or is naturally discharged by diffuse upward leakage in topographically low areas near the coast (Kasmarek and Robinson, 2004). Water in the coastal, deep zones of the aquifers is denser, and this higher density water causes the fresher, lower density water that has not been captured and withdrawn by wells to be redirected as diffuse upward leakage to shallow zones from the confined downdip areas of the aquifer system (Kasmarek and Robinson, 2004).

Previous Studies

An extensive well-monitoring network was established by 1977, and groundwater-level data were collected and used to create the first published groundwater-level-altitude maps of the Chicot and Evangeline aquifers in the Houston-Galveston region (Gabrysch, 1979). The FBSD adopted its groundwater management plan in 1990 (Fort Bend Subsidence District, 2013), and in cooperation with the FBSD, an increased number of wells were inventoried by the USGS in Fort Bend, Harris, Brazoria, and Waller Counties in 1989 and 1990. A more comprehensive groundwater-level-altitude report for the Chicot and Evangeline aquifers was published by the USGS in 1991 (Barbie and others, 1991) and was revised in 1997 when updated well data became available (Kasmarek, 1997). Similarly, after the establishment of the LSGCD in 2001, the USGS began publishing groundwater-level-altitude maps of the Jasper aquifer in the Houston-Galveston region (primarily Montgomery County) (Coplin, 2001). In 2004, 2006, and 2007, as additional wells with reliable groundwater-level data were inventoried, revised groundwater-level-altitude maps for the Jasper aquifer were prepared (Kasmarek and Lanning-Rush, 2004; Kasmarek and others, 2006; Kasmarek and Houston, 2007). In comparison to groundwater-level-altitude maps in the 2001 (Coplin, 2001) and 2004 (Kasmarek and Lanning-Rush, 2004) reports, the 2007 groundwater-level-altitude map (Kasmarek and Houston, 2007) was the most comprehensive for the Jasper aquifer in the study area prepared to date at that time. Since 2007, comprehensive maps for the Jasper aquifer have been included in the annual series of reports that depict groundwater-level altitudes and groundwater-level changes in the Chicot, Evangeline, and Jasper aquifers in the Houston-Galveston region (Kasmarek and Houston, 2008; Kasmarek and others, 2010, 2011, 2012, 2013, 2014, 2015, 2016; Johnson and others, 2011; Kasmarek and Ramage, 2017).

Methods

This section describes the methods used to (1) collect and process groundwater-level data used in this report, (2) determine groundwater-level altitudes, and (3) depict long-term groundwater-level changes in the study area. These methods are similar to those described in previous reports by Gabrysch (1979), Kasmarek and Houston (2007), and Kasmarek and Ramage (2017).

Groundwater-Level Measurements

Groundwater-level data were obtained from observation wells during December 2018 through March 2019 by measuring the depth to water below land-surface datum at each well to represent the 2019 groundwater-level altitudes of the Chicot, Evangeline, and Jasper aquifers. Most of the measurements were made by USGS personnel by using a calibrated steel tape, airline, or electric water-level tape in accordance with methods described in Cunningham and Schalk (2011).

In 2019, 19 measurements representing about 3 percent of the total number of all groundwater-level measurements were furnished by industrial entities and powerplants operating within the study area that use water for hydrocarbon processing and electrical power generation, respectively. The furnished water levels were typically measured by using air pressure to determine the saturated thickness above the pump intake, and multiple pressure measurements were usually collected as a quality-control measure. Air pressure measurements tend to provide less precision than do measurements made with either a steel tape or electric tape; therefore, all furnished measurements were rounded to the nearest foot.

Most of the measured wells were being pumped at least once daily and some more frequently during the study period. Therefore, well pumps were turned off for at least 1 hour before the groundwater-level measurements were made in order to obtain a groundwater-level measurement that approximated the static conditions within the aquifer. Antecedent withdrawal rates and pumping status of nearby wells were not always known and in such instances could have affected the representativeness of the groundwater-level data that were collected. To ensure that the recorded groundwater-level measurement was accurate, at least two groundwater-level measurements were made at each well while the well was not being pumped. After the groundwater-level-measurement data were collected, they were thoroughly evaluated and incorporated into a geographic information system (GIS) as point-data layers and subsequently used for the construction of groundwater-level-altitude and groundwater-level-change maps. The groundwater-level measurements collected or provided for this study were carefully reviewed by USGS personnel and are compiled in Ramage and Shah (2019). All collected and compiled water-level measurements were also loaded into the USGS National Water Information System (NWIS) (U.S. Geological Survey, 2018a).

Determination of Groundwater-Level Altitudes

The 2019 regional-scale depictions of groundwater-level altitudes presented in this report were derived from groundwater-level-measurement data collected throughout the 11-county study area from December 2018 through March 2019 (water levels usually are higher during these months compared to the rest of the year). Groundwater-level-altitude data were calculated by subtracting the groundwater-level measurement from the land-surface elevation at each well referenced to datum (National Oceanic and Atmospheric Administration, 2008). Prior to 2016, groundwater-level altitudes published in this annual series of USGS reports were referenced to either the National Geodetic Vertical Datum of 1929 or NAVD 88.

The accuracy of land-surface-elevation data at wells used in the annual series of reports has gradually improved over time as digital elevation models (DEMs) have supplanted traditional methods of determining land-surface elevations from topographic maps. The most accurate land-surface data available were used by the USGS for each historical annual depiction of groundwater-level altitudes in the study area. To determine land-surface elevations in 2019, a corresponding land-surface datum was obtained for each well by using a USGS National Geospatial Program 1-meter DEM that provides three-dimensional elevation values referenced to datum (Arundel and others, 2015; U.S. Geological Survey, 2018b). The height above land surface of the measuring point at each well was measured with an engineering ruler. In 1977, land-surface-elevation data were calculated from USGS 1:24,000-scale 7.5-minute topographic quadrangle maps for the Gulf of Mexico coastal area, which have a 5-ft contour as described in Gabrysch (1979), thereby providing an accuracy of 2.5 ft. The DEM used to determine land-surface elevation in 2019 provides an accuracy of 0.5 ft.

The 2019 groundwater-level altitudes measured in wells completed in the Chicot, Evangeline, and Jasper aquifers are depicted on contour maps with 50-ft contour intervals. The groundwater-level-altitude contours are approximate, regional-scale depictions of the water levels in wells in the Chicot, Evangeline, and Jasper aquifers, and the areal extents and locations of these contours represent the combined effects of total groundwater withdrawals from all groundwater wells screened in the Gulf Coast aquifer system.

Depicting Long-Term Groundwater-Level Changes

Maps depicting changes in groundwater-level altitudes in the Chicot, Evangeline, and Jasper aquifers were constructed for the period of record available for each of the aquifers; data are from 1977 to 2019 for the Chicot and Evangeline aquifers and from 2000 to 2019 for the Jasper aquifer. Groundwater-level-change maps were constructed by contouring the set of mapped point values, computed either as the difference in groundwater-level altitude at each well for which a groundwater-level measurement was made in 2019 and in the historical year, or as the difference in the groundwater-level altitude at that point in 2019 and the groundwater-level altitude on a gridded surface of the historical year groundwater-level-altitude map (Gabrysch, 1979; Kasmarek and Houston, 2007). Gridded-surface values (rather than actual measured values) for the historical year were only used to compute differences (mapped point values) if the wells measured in 2019 did not exist in 1977 (for the Chicot and Evangeline aquifers) or 2000 (for the Jasper aquifer). The datasets of groundwater-level-change values (difference between 2019 and historical year groundwater-level-altitude values) are available in Ramage and Shah (2019) and Ramage and Braun (2019).

Groundwater-Level Altitudes and Long-Term Groundwater-Level Changes

Groundwater-level-altitude and long-term groundwater-level-change maps were constructed for the Chicot, Evangeline, and Jasper aquifers in the study area (figs. 4–9). Whereas the aquifer maps in this report depict approximate groundwater-level altitudes for 2019 (figs. 4, 6, and 8) by using 50-ft contour intervals, 20-ft contour intervals were used to depict groundwater-level changes for 1977–2019 in the Chicot aquifer (fig. 5), 40-ft contour intervals were used for 1977–2019 in the Evangeline aquifer (fig. 7), and 20-ft contour intervals were used for 2000–19 in the Jasper aquifer (fig. 9). All long-term groundwater-level changes in this report are considered approximate. Locations of wells used to construct the 2019 groundwater-level-altitude maps for the Chicot, Evangeline, and Jasper aquifers are presented in Ramage and Shah (2019) and Ramage and Braun (2019). Certain groundwater-level altitude measurements collected during December 2018 through March 2019 were not used to construct the contour maps presented in this report for the Chicot, Evangeline, and Jasper aquifers for one or more of the following reasons: (1) the well in question was likely screened in a shallower part of the aquifer or with a smaller depth interval compared to nearby wells completed in the same aquifer, and the water-level altitudes recorded at the well in question were not consistent with water-level altitudes obtained from other wells completed in the same aquifer that were likely screened in deeper parts of the aquifer or screened with larger depth intervals that provided better communication between the well and surrounding aquifer compared to the well in question; (2) the well in question might have been pumped recently and the water-level altitude at this well was still rising and not in agreement with water-level altitudes at nearby wells that were more representative of static conditions; or (3) the well in question might be near one or more other wells with water-level altitudes that more closely match those of the regional water table, such that retaining the water-level altitude from the well in question would result in a localized "bullseye" contour or otherwise unrealistic looking contour pattern. The companion data release by Ramage and Braun (2019) identifies the water-level altitude measurements that were used to construct the contour maps for each aquifer.

Chicot Aquifer

Groundwater-level-measurement data from 168 wells (Ramage and Braun, 2019) were used to depict the approximate 2019 groundwater-level-altitude contours for the Chicot aquifer (fig. 4). In 2019, groundwater-level-altitude contours for the Chicot aquifer ranged from 200 ft below datum in a small area (less than 1 square mile) in northwestern Harris County near Jersey Village, Tex., to 200 ft above datum west of Conroe, Tex., in Montgomery County.

The largest decline in groundwater-level altitudes (100 ft) indicated by the 1977–2019 groundwater-level-change contours for the Chicot aquifer was also in northwestern Harris County near Jersey Village (fig. 5). The largest rise in groundwater-level altitudes in the Chicot aquifer from 1977 to 2019 (200 ft) was in southeastern Harris County between Deer Park, Tex., and Baytown, Tex. (fig. 5).

Evangeline Aquifer

Groundwater-level-measurement data from 331 wells (Ramage and Braun, 2019) were used to depict the approximate 2019 groundwater-level-altitude contours for the Evangeline aquifer (fig. 6). In 2019, groundwater-level-altitude contours for the Evangeline aquifer ranged from 300 ft below datum near Jersey Village in Harris County to 200 ft above datum at two locations in northwestern Montgomery and southern Walker Counties, and in the southeastern part of Grimes County.

The 1977–2019 groundwater-level-change contours for the Evangeline aquifer (fig. 7) depict broad areas where groundwater-level altitudes either declined or rose. The largest decline in groundwater-level altitudes in the Evangeline aquifer from 1977 to 2019 (280 ft) was in southern Montgomery and northern Harris Counties, near The Woodlands, Tex. (fig. 7). The largest rise in groundwater-level altitudes in the Evangeline aquifer from 1977 to 2019 (240 ft) was in southeastern Harris County along Buffalo Bayou near Galena Park, Tex. (fig. 7).

Jasper Aquifer

Groundwater-level-measurement data from 99 wells (Ramage and Braun, 2019) were used to depict the approximate 2019 groundwater-level-altitude contours for the Jasper aquifer (fig. 8). In 2019, groundwater-level-altitude contours for the Jasper aquifer ranged from 200 ft below datum at two locations near The Woodlands in northern Harris and southern Montgomery Counties to 250 ft above datum in northeastern Grimes County, northwestern Montgomery County, and southwestern Walker County (fig. 8).

Whereas annual groundwater-level-altitude data have been collected since 1977 from wells completed in the Chicot and Evangeline aquifers, annual groundwater-level-altitude data have been collected from wells completed in the Jasper aquifer since only 2000. The 2000–19 groundwater-level-change contours for the Jasper aquifer (fig. 9) depict groundwater-level declines throughout most of the study area where groundwater-level-altitude data from the Jasper aquifer were collected, with the largest decline (200 ft) in southern Montgomery County between Spring, Tex., and The Woodlands.

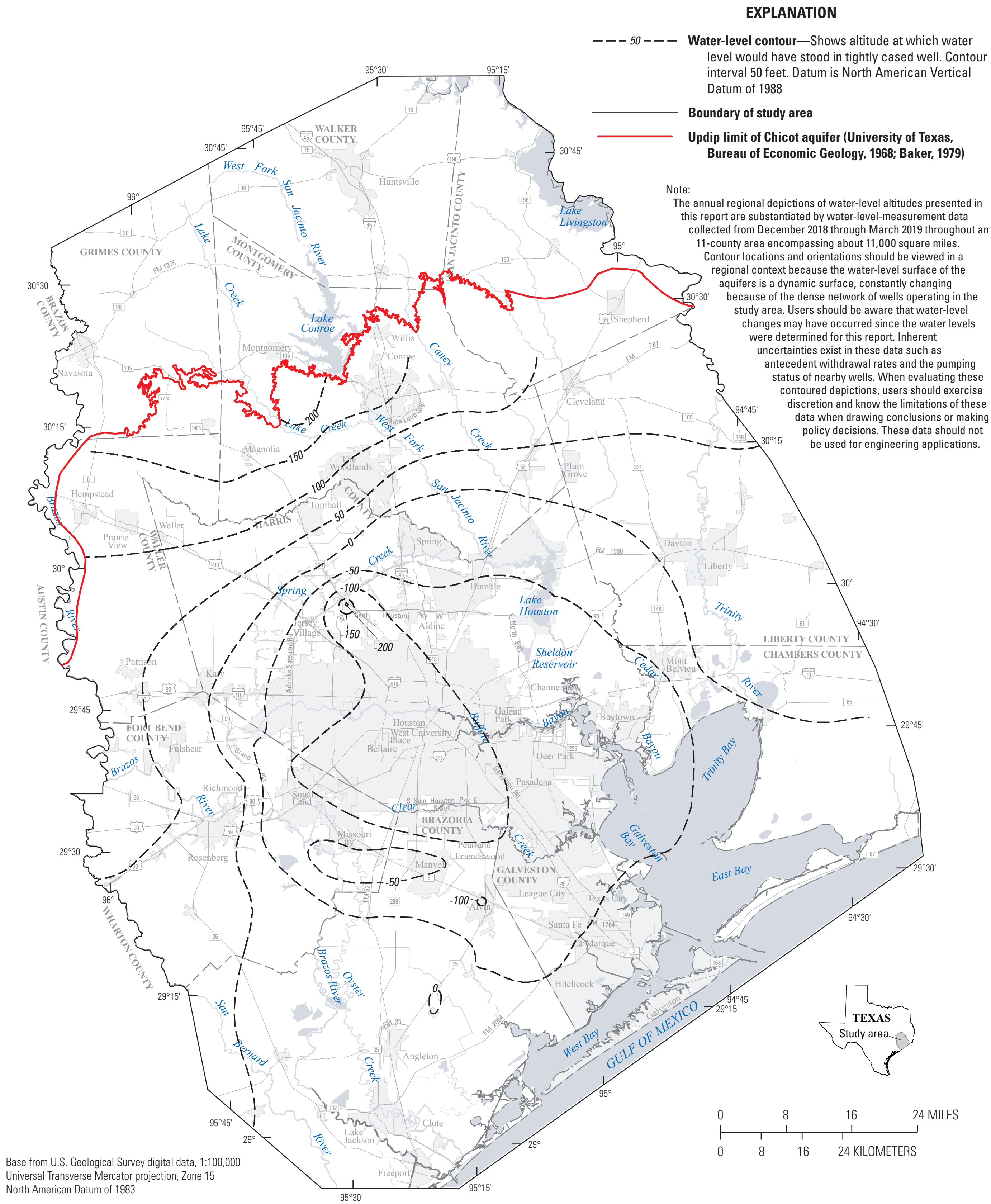


Figure 4. Approximate 2019 groundwater-level altitudes and updip limit of the Chicot aquifer, Houston-Galveston region, Texas (groundwater-level-measurement data collected during December 2018 through March 2019).

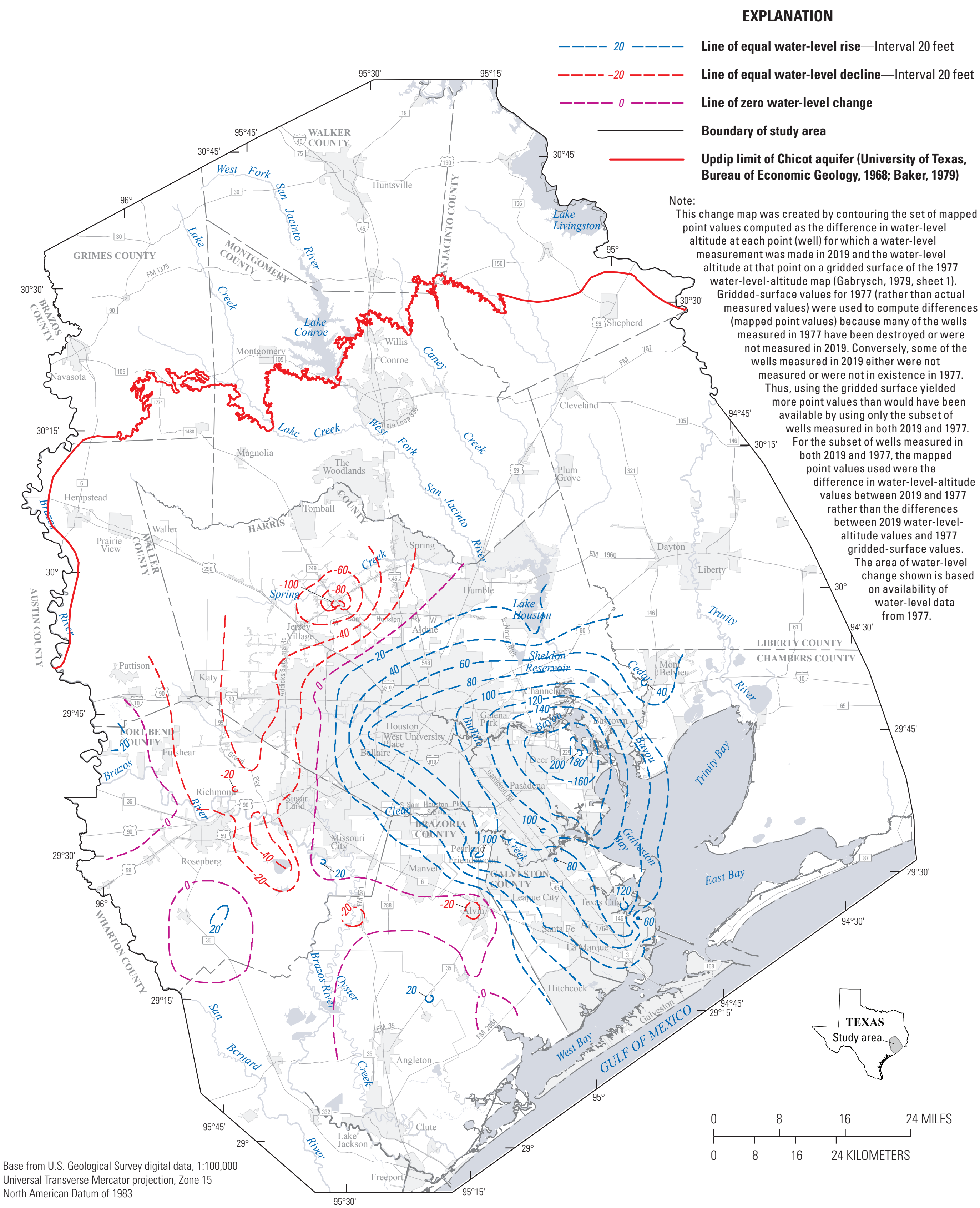


Figure 5. Approximate 1977–2019 groundwater-level changes in the Chicot aquifer, Houston-Galveston region, Texas.

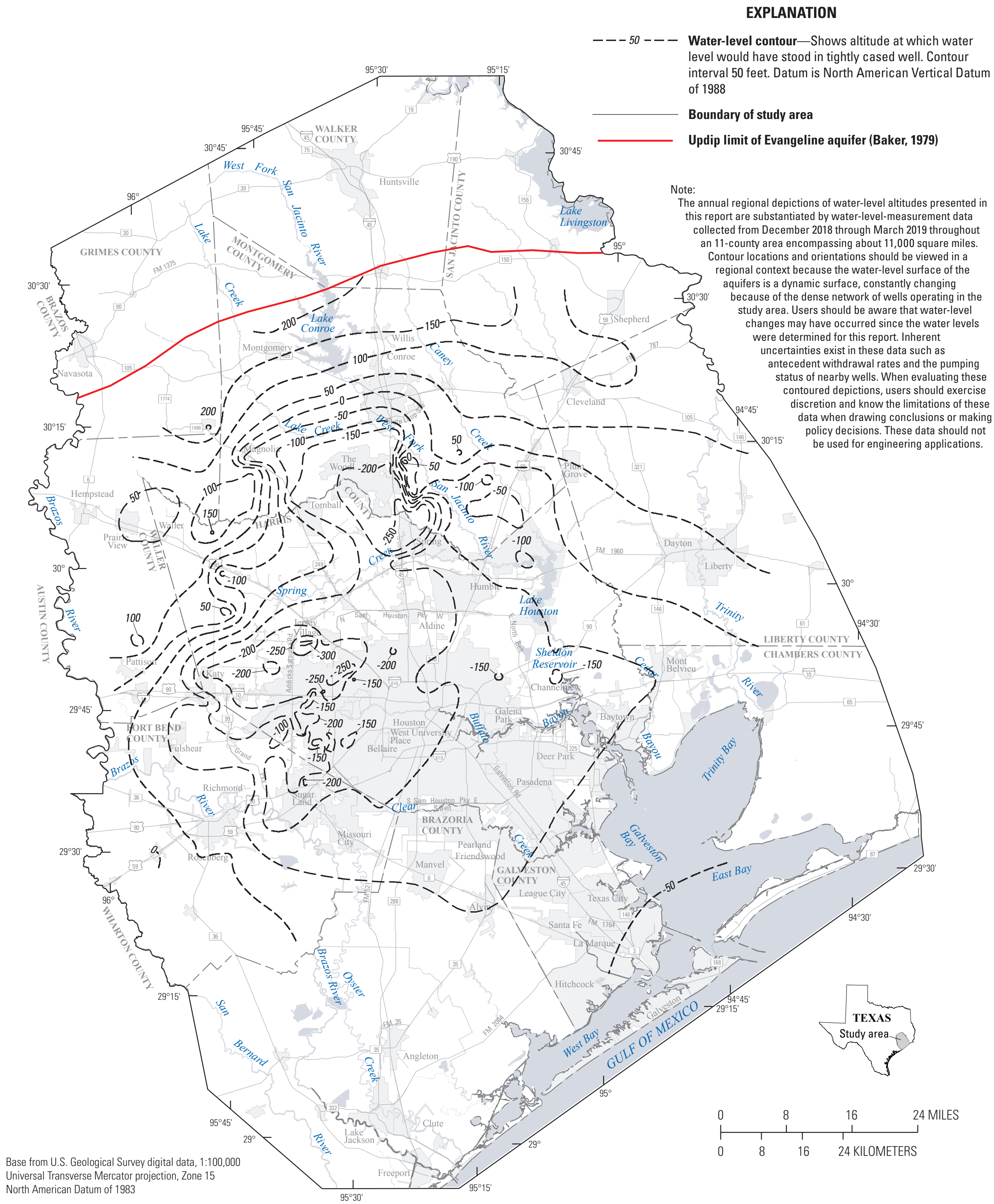


Figure 6. Approximate 2019 groundwater-level altitudes and updip limit of the Evangeline aquifer, Houston-Galveston region, Texas (groundwater-level-measurement data collected during December 2018 through March 2019).

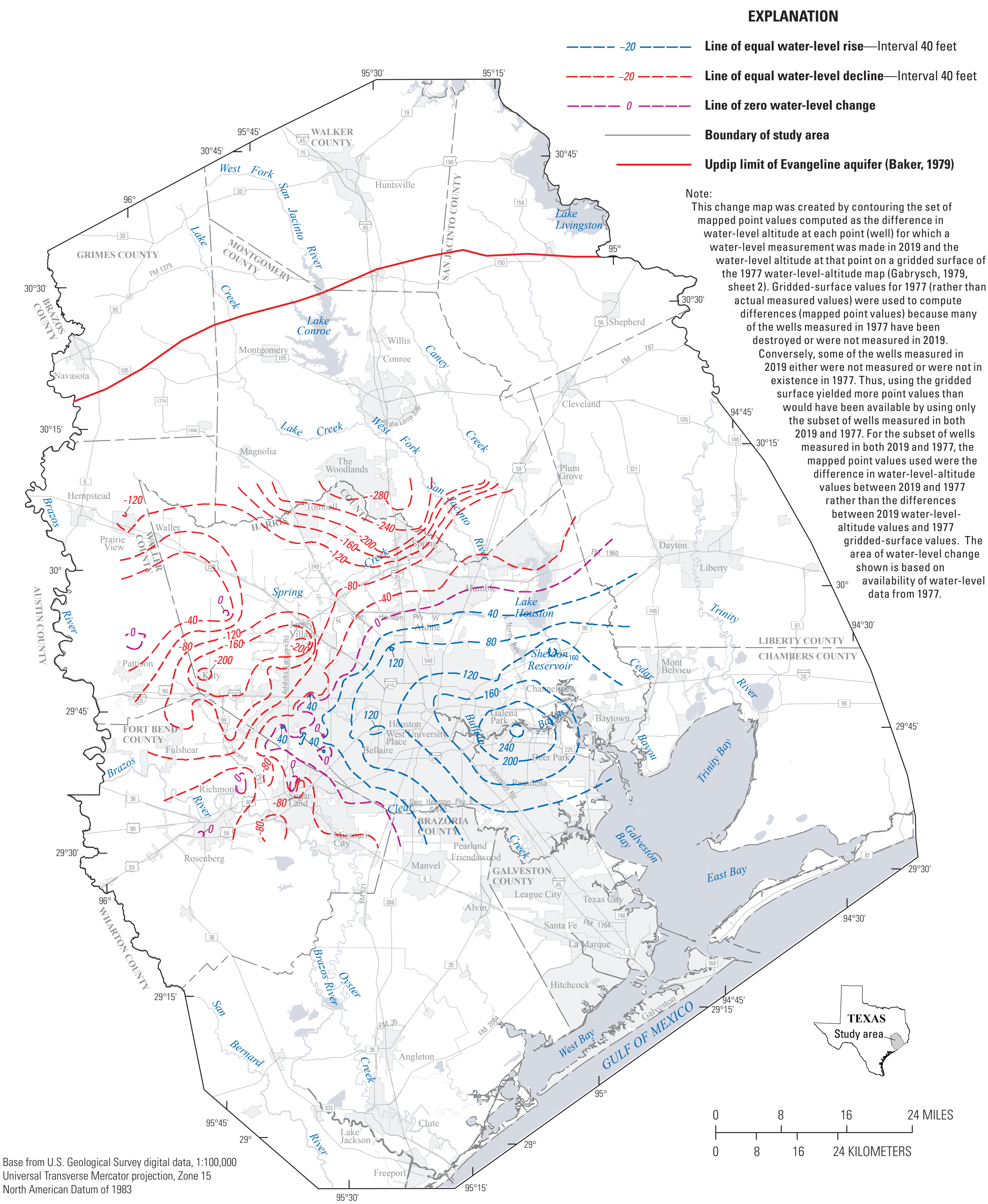


Figure 7. Approximate 1977–2019 groundwater-level changes in the Evangeline aquifer, Houston-Galveston region, Texas.

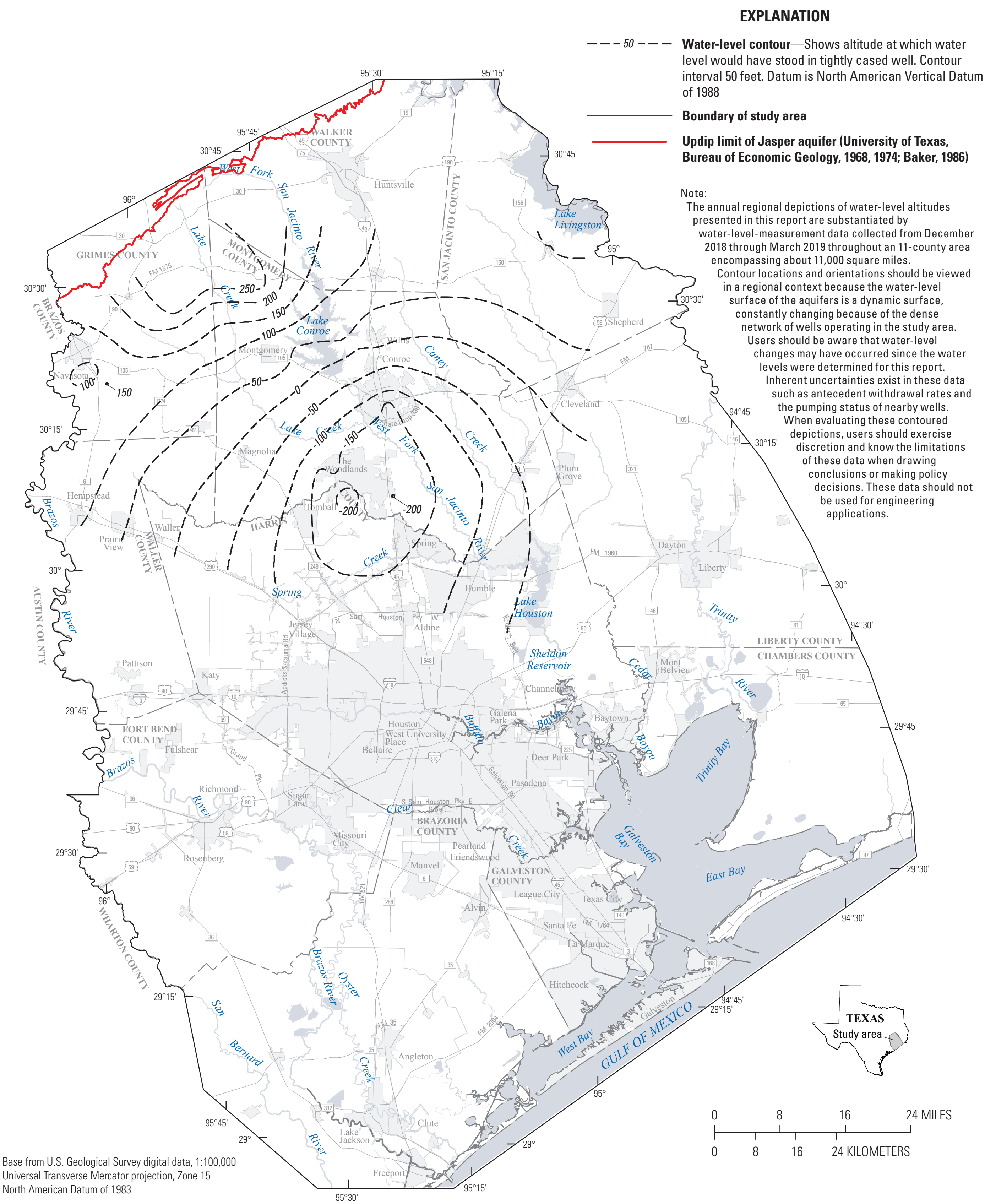


Figure 8. Approximate 2019 groundwater-level altitudes and updip limit of the Jasper aquifer, Houston-Galveston region, Texas (groundwater-level-measurement data collected during December 2018 through March 2019).

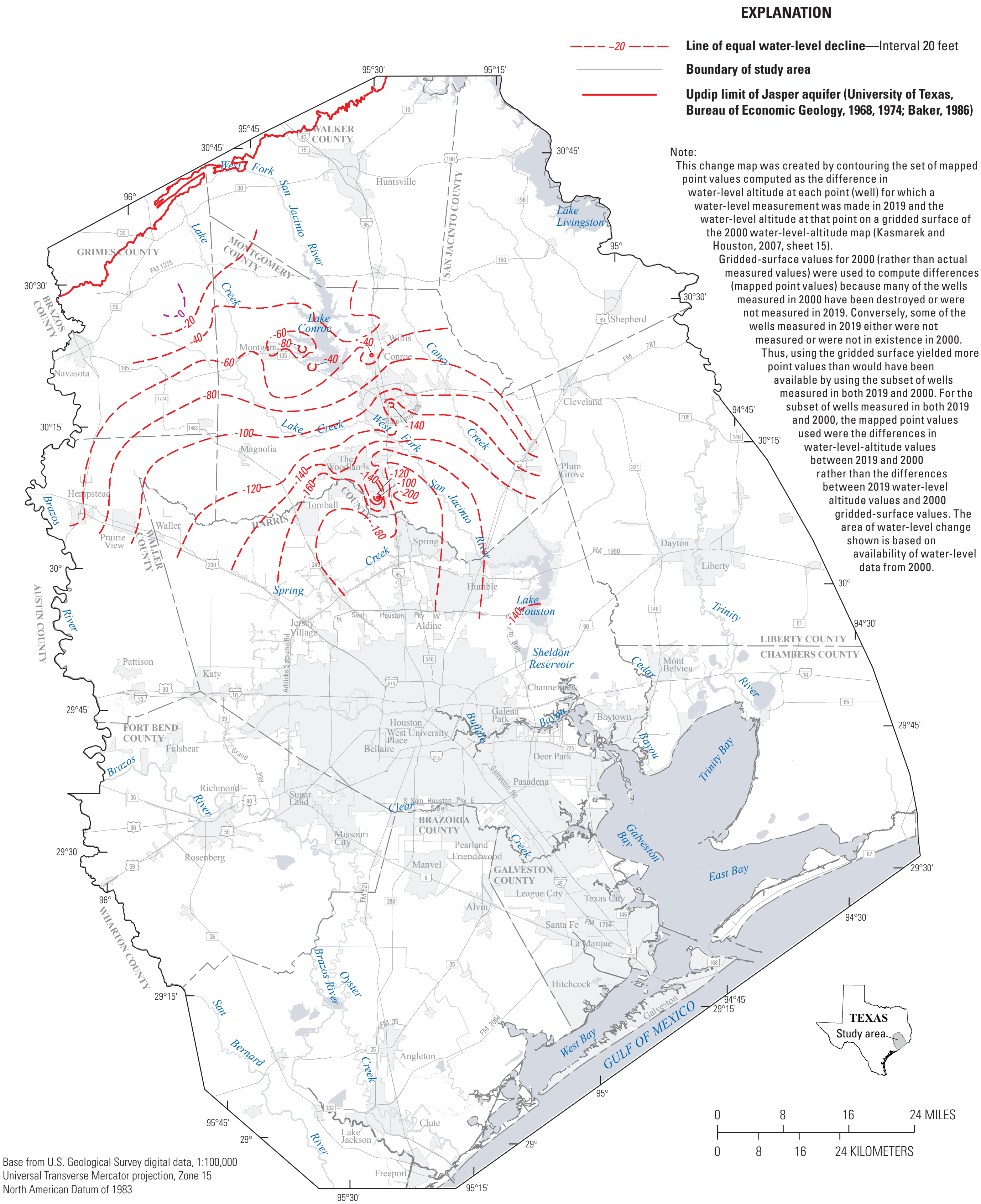


Figure 9. Approximate 2000–19 groundwater-level changes in the Jasper aquifer, Houston-Galveston region, Texas.

Data Limitations

As described in the “Methods” section, the accuracy of the land-surface-elevation data has gradually improved over time. Any changes in land-surface elevation could affect the accuracy of groundwater-level-change maps depicting the differences between the current year (2019) and the historical year (1977 or 2000) altitudes (Kasmarek and Ramage, 2017).

The depictions of groundwater-level altitudes and changes at any specific location are considered to represent a regional-scale approximation and, as such, are not intended for use in engineering or other design applications. The groundwater-level altitudes and changes presented in this report were rounded to the nearest foot; the values depicted on the maps represent a mathematical approximation that could vary as much as plus or minus 0.5 ft in addition to accuracies associated with the DEM source data. Users should exercise discretion when drawing conclusions or making policy decisions based on these contoured depictions.

Summary

The Houston-Galveston region, Texas, consists of Harris, Galveston, Fort Bend, Montgomery, Brazoria, Chambers, Grimes, Liberty, San Jacinto, Walker, and Waller Counties. Groundwater withdrawn from the three primary aquifers that compose the Gulf Coast aquifer system—the Chicot, Evangeline, and Jasper aquifers—has been the primary source of water for municipal supply, commercial and industrial use, and irrigation in the Houston-Galveston region since the early 1900s. This report, prepared by the U.S. Geological Survey in cooperation with the Harris-Galveston Subsidence District, City of Houston, Fort Bend Subsidence District, Lone Star Groundwater Conservation District, and Brazoria County Groundwater Conservation District, is one in an annual series of reports depicting the status of groundwater-level altitudes and groundwater-level changes in the Chicot, Evangeline, and Jasper aquifers in the Houston-Galveston region. Water levels in wells screened in these aquifers were measured during December 2018 through March 2019 (water levels usually are higher during these months compared to the rest of the year).

This report contains regional-scale maps depicting approximate 2019 groundwater-level altitudes and long-term groundwater-level changes in the Chicot, Evangeline, and Jasper aquifers. Groundwater-level measurements from 168, 331, and 99 wells were used to depict the approximate 2019 groundwater-level-altitude contours for the Chicot, Evangeline, and Jasper aquifers, respectively.

In 2019, groundwater-level-altitude contours for the Chicot aquifer ranged from 200 feet (ft) below the North American Vertical Datum of 1988 (hereinafter referred to as “datum”) to 200 ft above datum. The 1977–2019 groundwater-level-change contours for the Chicot aquifer depict a large area of decline in groundwater-level altitudes (100 ft) in northwestern Harris County near Jersey Village, Tex. The largest rise in groundwater-level altitudes in the Chicot aquifer from 1977 to 2019 (200 ft) was in southeastern Harris County between Deer Park, Tex., and Baytown, Tex.

In 2019, groundwater-level-altitude contours for the Evangeline aquifer ranged from 300 ft below datum to 200 ft above datum. The 1977–2019 groundwater-level-change contours for the Evangeline aquifer depict broad areas where groundwater-level altitudes either declined or rose. The largest decline in groundwater-level altitudes in the Evangeline aquifer from 1977 to 2019 (280 ft) was in southern Montgomery and northern Harris Counties, near The Woodlands, Tex. The largest rise in groundwater-level altitudes in the Evangeline aquifer from 1977 to 2019 (240 ft) was in southeastern Harris County along Buffalo Bayou near Galena Park, Tex.

In 2019, groundwater-level-altitude contours for the Jasper aquifer ranged from 200 ft below datum to 250 ft above datum. Whereas annual groundwater-level-altitude data have been collected since 1977 from wells completed in the Chicot and Evangeline aquifers, annual groundwater-level-altitude data have been collected from wells completed in the Jasper aquifer since only 2000. The 2000–19 groundwater-level-change contours for the Jasper aquifer depict groundwater-level declines throughout most of the study area where groundwater-level-altitude data from the Jasper aquifer were collected, with the largest decline (200 ft) in southern Montgomery and northern Harris Counties.

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For more information about this publication, contact

Director, Texas Water Science Center
U.S. Geological Survey
1505 Ferguson Lane
Austin, TX 78754–4501

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